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# CONTENTS OF NEW SERIES, VOLUME LXVIII

## ORIGINAL ARTICLES

Surgical Management of Vascular Trauma . . .	<i>Captain H. L. Pugh . . .</i>	5
Painful Scar and Other Surgical Neuroses. . .	<i>Theodore L. Hyde . . .</i>	21
Potential Anatomical Spaces in the Face . . .	<i>Major Joseph G. Kostrubala . . .</i>	28
Urological Manifestations Associated with Chronic Appendiceal Abscess . . . . .	{ <i>Joseph A. Lazarus . . . . .</i> <i>Morris S. Marks . . . . .</i> }	38
Intrasternal Infusions in Obstetrical Hemorrhage. . . . .	{ <i>M. D. Schnall . . . . .</i> <i>R. J. Heffernan . . . . .</i> }	44
Simplified Procedure for the Treatment of Impassable Urethral Strictures and Rupture of the Urethra . . . . .	<i>Thomas E. Gibson . . . . .</i>	49
Two-stage Mammoplasty in Relation to Blood Supply . . . . .	<i>Jacques W. Maliniac . . . . .</i>	55
Renal Ectopia. A Study of Twenty-three Cases . . .	<i>Earl F. Nation . . . . .</i>	67
Hemorrhoidectomy by Incision and Dissection . . .	<i>Captain Philip H. Rakov . . . . .</i>	73
Pilonidal Cyst. . . . .	{ <i>Capt. Mark J. Brockbank . . . . .</i> <i>Lt. Col. Joe R. Floyd . . . . .</i> }	77
Dicumarol in Surgery . . . . .	<i>De Witt C. Daughtry . . . . .</i>	80
Epigastric Hernia. An Improved Method of Repair . . .	<i>Edgar F. Berman . . . . .</i>	84
Tube Feeding . . . . .	{ <i>Frank H. Kidd, Jr. . . . .</i> <i>Vesta Odell . . . . .</i> }	87
Joint Aspiration. A Simple Method . . . . .	<i>Captain David Goldberg . . . . .</i>	89
Inversion of the Appendiceal Stump. An Improved Method . . . . .	<i>Joseph J. Stratte . . . . .</i>	91
True Oxycephaly with Syndactylism. Case Report . . .	<i>Bernard N. E. Cohn . . . . .</i>	93
Air Embolism in Obstetrics and Gynecology . . .	<i>William F. Finn . . . . .</i>	100
Suppurative Typhoid Spine Perforating into the Bronchus. Case Report . . . . .	{ <i>E. K. Johnson . . . . .</i> <i>Arthur James . . . . .</i> }	103
Massive Delayed Hemorrhage Following Traumatic Rupture of Spleen as a Complication of Full Term Pregnancy . . . . .	{ <i>Carl Ireneus, Jr . . . . .</i> <i>Benson F. Deardorff . . . . .</i> <i>Gil Ehlers . . . . .</i> }	107
Chemotherapy in Frostbite. Case Report . . . . .	<i>William Y. Lee . . . . .</i>	113
Spastic Calcaneocavus Foot Deformity . . . . .	<i>Major Adolph A. Schmier . . . . .</i>	116



Duodenal Atresia in the Newborn. Case Report . . . . .	{ <i>W. C. Sumner</i> . . . . . <i>Kenneth A. Morris</i> . . . . . }	120
Solitary Cyst of the Kidney. Case Report. : . . . .	{ <i>David Kershner</i> . . . . . <i>Leon N. Kessler</i> . . . . . }	124
Physiology of the Unshod and Shod Foot with an Evolutionary History of Footgear . . . . .	<i>S. F. Stewart</i> . . . . .	127
Treatment of Abdominal Injuries. Review of Eighty-eight Personal Cases . . . . .	{ <i>J. Leonard Dixon</i> . . . . . <i>George Martin</i> . . . . . <i>Alton Ochsner</i> . . . . . }	143
Air Embolism. Fatal Air Embolism Due to Powder Insufflators Used in Gynecological Treatments. . . . .	<i>Harrison S. Martland</i> . . . . .	164
Refrigeration in General Surgery of Limbs . . . . .	<i>Frederick M. Allen</i> . . . . .	170
Positive Pressure Respiration in the Treatment of Acute Pulmonary Edema . . . . .	<i>F. Paul Ansbro</i> . . . . .	185
Skin Grafting by the General Surgeon. . . . .	<i>Joseph C. Urkov</i> . . . . .	195
New Technic for Reconstruction of the Oviducts. . . . .	<i>David Polowe</i> . . . . .	208
Non-splinting Treatment of Elbow Joint Injuries. A Report of Its Use in Twenty Cases . . . . .	{ <i>Thomas A. Boutrous</i> . . . . . <i>Alexander Blain III</i> . . . . . <i>W. A. Chipman</i> . . . . . }	212
Acute Cholecystitis. A Comparative Study of the Mortality Rate after Immediate and Delayed Operations . . . . .	<i>Walter J. McGuigan</i> . . . . .	219
Cellophane in Bone and Joint Surgery. . . . .	{ <i>Captain Garth H. Harley</i> . . . . . <i>Major Louis W. Breck</i> . . . . . }	229
Sulfathiazole-Codliver Oil Ointment in the Post- operative Care of the Septic Hand . . . . .	<i>Captain David Brezin</i> . . . . .	232
Delayed Rupture of the Extensor Pollicis Longus Tendon Following Colles's Fracture . . . . .	<i>Donald E. Coburn</i> . . . . .	234
Multiple Primary Malignant Neoplasms of the Rectum and Sigmoid Colon. Report of Five Additional Cases . . . . .	{ <i>Harry E. Bacon</i> . . . . . <i>Orville C. Gass</i> . . . . . }	240
natic Infarction of the Kidney . . . . .	{ <i>W. K. Rexford</i> . . . . . <i>Paul J. Connolly</i> . . . . . }	250
ary Calculi. Case Report . . . . .	<i>Jacob M. Teske</i> . . . . .	254
aptured Anastomotic Aneurysm of Gastric Arteries. Case Report and Review of Literature . . . . .	<i>Carl E. Taylor</i> . . . . .	258
Hypertrophic Gastritis Simulating Carcinoma . . . . .	<i>Charles M. Harris</i> . . . . .	261

Removal of Metallic Bodies with the Aid of a Metal Locator . . . . .	<i>James H. Skiles . . . . .</i>	266
Simplified Humeral Splint . . . . .	<i>Arnold A. Spiegler . . . . .</i>	268
Walking Iron with a Foot Plate. . . . .	<i>{B. Koven . . . . . M. T. Koven . . . . .}</i>	270
Arnaldus Villanova. Incunabula Medica ix . . .	<i>Felix Cunha . . . . .</i>	272
Air Embolism. With Special Reference to Its Surgical Importance . . . . .	<i>Harrison S. Martland . . . . .</i>	281
Hernia in Infancy and Childhood . . . . .	<i>Alfred H. Iason . . . . .</i>	287
Pediatric Urological Problem Important to the General Practitioner . . . . .	<i>Ralph U. Whipple . . . . .</i>	297
Primary Omental Torsion . . . . .	<i>{Joseph I. Anton . . . . . John E. Jennings . . . . . Milton B. Spiegel . . . . .}</i>	303
Intercostal Nerve Block in Balanced Anesthesia. *	<i>Stanton Belinkoff . . . . .</i>	318
Operation for Anal Fistulas. Some Reasons for Failures . . . . .	<i>Raymond J. Jackman . . . . .</i>	323
Fixity of Facial Expression Following Undermining of the Skin over the Nose. A Modified Method by Which It Is Avoided . . . . .	<i>Albert P. Seltzer . . . . .</i>	326
Failure of Cure of Pelvic Infections Following the Use of Penicillin . . . . .	<i>Lt. Comdr. Thomas B. Marwil . . . . .</i>	336
Prosthetic Restorations after Amputations about the Hand . . . . .	<i>Adolph M. Brown . . . . .</i>	338
Transverse Incision for Appendectomy . . . .	<i>Lt. Comdr. Sam D. Murray . . . . .</i>	344
Clinical Use of a Red Cell Amino Acid Mixture as a Substitute for Whole Blood Transfusions. .	<i>{Lt. Col. B. G. P. Shafiroff . . . . . I. S. Barcham . . . . . Captain H. Doubilet . . . . .}</i>	348
Bridge Operation for Dupuytren's Contracture .	<i>{Louis A. Palmer . . . . . James L. Southworth . . . . .}</i>	351
Response to Preoperative Irradiation as a Clue to the Management of Breast Cancer . . . . .	<i>Leo M. Levi . . . . .</i>	355
Mikulicz's Disease. A Report on a Patient Treated with Penicillin . . . . .	<i>Arnold S. Jackson . . . . .</i>	358
Solitary Diverticulitis of the Cecum . . . . .	<i>{Captain Zenas B. Noon . . . . . Lt. Col. Harry L. Schenk . . . . .}</i>	364
Postoperative Physiological Changes in Regional Ileitis . . . . .	<i>{Comdr. Edwin M. Jameson . . . . . Lt. Comdr. Waldo O. Hoey . . . . .}</i>	369

## Contents

Complete Avulsion of the Scalp. Review of the Literature and Case Report . . . . .	<i>Lester W. Eisenstodt</i> . . . . .	376
Pyopneumothorax in the First Month of Life with Recovery. Two Case Reports. . . . .	{ <i>G. P. Rosemond</i> . . . . . <i>H. T. Caswell</i> . . . . .}	383
Intractable Peptic Ulcer . . . . .	<i>F. Gregory Connell</i> . . . . .	388
Lymphangioma of the Abdomen. An Unusual Case	{ <i>Lt. Colonel C. F. Murbach</i> . . . . . <i>Major E. F. Lewison</i> . . . . . <i>Captain G. A. Deibert</i> . . . . .}	391
Acute Phlegmonous Cecitis . . . . .	{ <i>Leo M. Meyer</i> . . . . . <i>Raymond Disch</i> . . . . .}	398
Modification of the Nosik-Gardner Suction Irrigator. . . . .	<i>Edward W. Shannon</i> . . . . .	401
New Circumcision Clamp . . . . .	<i>F. M. Al Akl</i> . . . . .	402

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## Editorial

### THE ARMED SERVICES AND MEDICAL EDUCATION

IN a paper read at the Conference on Medical Education in Chicago and published in the Journal of the A. M. A., February 16, 1918, Major Horace D. Arnold,<sup>1</sup> M.R.C., U. S. Army, suggested it would be possible to give three terms in twelve months, instead of two terms, as was the rule, in our medical schools, without any material detriment to the course of instruction. Dr. Arnold said, "The desirability of the general idea of speeding up medical education, without sacrifice of its quality, has the approval of the Surgeon-General."

In the June 1, 1918, number of the same journal, Dr. George Dock,<sup>2</sup> of St. Louis, replied to this suggestion for an accelerated medical course by saying the idea did not catch on . . . "There was very little discussion over this novel plan. Many of those who spoke left the main subject and dilated on the waste of time in vacations by teachers and students, the extravagance of empty class rooms, etc. . . ." In another part of his paper Dr. Dock continued, "All agree . . . that the present standard in medical education must be kept up, and that no concession should be made to those

who raise the specious plea of war need to lower the standards of entrance and of graduation." Instead of lowering medical standards and jamming ill prepared men through a medical mill Dr. Dock offered the following suggestion: "Let the colleges retain their present terms until a better plan can be adopted. Send all medical students, about the middle of June, to camps of instruction and keep them there until a week or two before the fall term. In the first summer let the training be physical and military . . . In the second summer put the men in hospitals at training camps. Continue exercise, and train in the work of hospital orderlies, so as better to treat others . . . Part of the 'paper work' could be learned at this time. . . . In the third year, also in hospitals, as assistants, the more medical duties as well as 'paper work' could be finished. . . . At the end of the intern year (they proposed to permit interns one year of training) the young medical officer could at once take up his work, and be physically, militarily and medically much more useful than he is now."

We were told that due to the objections raised by Dr. Dock and other medical gentlemen interested in this subject, the three year medical education plan fell by the wayside. Dr. Dock's plan to train future medical officers during their vaca-

<sup>1</sup> HORACE D. ARNOLD, M.R.C., U.S.A., Washington, D. C. Medical education, medical interns and the war. *J. A. M. A.*, 70: 45, 1918.

<sup>2</sup> GEORGE DOCK, M.D., St. Louis. All year medical study and the education of medical officers. *J. A. M. A.*, 70: 1595, 1918.

tions was not accepted. From what we have heard and read concerning present day medical education, it is too bad someone early in this war did not exhume the papers and discussions on this subject published during the last war, and study them in a critical light. For, many physicians, especially those dealing with medical students or interested in medical education, believe that great harm, unnecessary harm, has been and is being done by the present hurry-up system or method of turning out poorly trained young men in medicine.

Dr. Evarts A. Graham in a recent issue of *The Saturday Evening Post* (January 27, 1945) wrote a pertinent and timely article on this topic, "Have the Armed Services Crippled Medical Education?" Because of his prominence and high standing in the profession one must give serious consideration to the many facts Dr. Graham presents in his thesis. We wish we could publish his article *in toto*. We hope most of our readers read it. At best we can only quote Dr. Graham in part and skim the highlights.

Dr. Graham opens his article by stating that although much has been said regarding our unpreparedness before Pearl Harbor, "In at least one respect, however, we were very well prepared. We had the largest group of the most splendidly educated medical specialists in our whole history. Thousands of these highly trained professional men were at once ready for mobilization and use by the armed forces. . . . They came immediately into the war, bringing the most up-to-date methods and techniques for the prevention of disease and for the treatment of the sick and wounded. . . . The professional work done by these medical officers has been extravagantly praised by many of the writers for the popular magazines and by the Surgeon General of the Army, Maj. Gen. Norman T. Kirk." We are told that 90 per cent of the wounded who reach the hospitals are saved.

All this is no surprise to those in the know. To those who have been engaged

in medical education it has been only what was expected. The thing that surprises most people is the fact that the Army and Navy "have adopted policies which have already effectively prevented our medical schools and hospitals from continuing the supply of trained doctors for the armed services. . . . The public is too much inclined to think that the performance of medicine on the battle fronts has been due to the newer drugs and to the use of blood plasma . . . but valuable as these things are, they do not deserve the credit. Nor could any miracle gadgets in themselves achieve a record such as has been accomplished. It is the splendid civilian professional training in the various specialities of medical practice which is responsible."

The Surgeon General of the Army said, "The thing that's saving lives is surgery—surgery—surgery—plus plenty of blood plasma, penicillin and the sulfa drugs, and the fact that the whole setup was so well planned in advance."

Dr. Graham asks why it happened that these well trained medical officers were available to the Army and Navy immediately after our entrance into the war. He gave the answers: He traced the history and growth of medicine since the turn of the century. Medical education changed. The proprietary and fly-by-night medical schools closed forever. The educational requirements prior to beginning the study of medicine were raised. One had to have had at least two years of college work, mostly in the basic sciences before he was eligible to study medicine. The American College of Surgeons, founded in 1913, went about the business of grading hospitals and required minimum standards for recognition by the College, to the end that the intern would have a place for adequate or superior training. "Other branches of medical practice have organized for similar purposes . . . Under the auspices of the American Medical Association, fifteen specialty boards have been created, representing practically all the recognized spe-

cialties in medical practice." In this way young physicians in recent years have been of a well trained highly efficient order. In other words, they knew their "stuff."

With this in mind Dr. Graham observes: "One might suppose that a plan that has been demonstrated to be effective in the preparation of medical officers would be allowed to continue in order to supply replacements of the same caliber. But instead, it has been scrapped by the War and Navy departments. Paradoxical as it seems, the program which probably supplied the best prepared officers of any group of the civilian population to enter immediately into wartime activities has been destroyed, although we are constantly told that the end of the war is by no means in sight. . . . At the present time, every physically fit male medical student is destined to become a medical officer in either the Army or Navy. Despite the fact that laymen in the War and Navy departments who have no expert knowledge of medical education have specified what the premedical course shall be, and have caused the reduction of the faculties of the medical schools by about 40 per cent and the streamlining of the course, the undergraduates are receiving fairly good instruction, although not nearly so good as in the prewar days."

A directive was issued on April 3, 1943, that "after July 1, 1943, the total number of residents *permitted* for the hospitals of the United States shall not exceed 50 per cent of the number of residents on duty in the hospitals on July 15, 1940." No exception was made, . . . all hospitals were in the "same basket," the little country institution and the large teaching hospital connected with a medical school. It was further decreed that "The internship shall be reduced to nine months. One third of the interns who hold commissions in the Army and Navy may be deferred for nine months (10th to 18th months). One half of this number or one sixth of the total number of commissioned interns may be

deferred for an additional nine months (19th to 27th months)."

This has since become known as the "9-9-9 plan."

The time tried and successful plan found to be efficient in producing well trained physicians and surgeons has been destroyed. The nine months' internship must be a rotating one. One had to divide during the nine months the following specialties . . . medicine, surgery, obstetrics, gynecology, psychiatry, dermatology, ear, nose and throat, pediatrics, and so on and on. As Dr. Graham observes, "Not enough of any of these subjects could be learned in that way to be dignified by the word 'smattering.'"

We are told that about two-thirds of all male interns (about 4,000) will enter active military service. Most of these men will have had at best but a few months experience in surgery. We read, "The Army lives by its tables of organization. Early in this war, we were told that it would need 6.5 medical officers for every 1000 men. This ratio was determined in time of peace, when only a small Army was contemplated. It was extravagant even then, but when an Army of 8,000,000 and a Navy of 2,500,000 were contemplated, it meant that 68,250 medical officers would have to be found, practically all from civil life—approximately 42 per cent of all the living graduates of medical schools, whether in active practice or not. It is a well known American characteristic that we react with almost hysterical violence to an emergency. The general philosophy of those responsible for this policy seems to be, "Better have a lot of poorly trained medical officers than fewer well trained ones."

Then Dr. Graham asks us to stick to cold statistics so we can see why a demand by the armed services for more than 40 per cent of the doctors of the country may be termed extravagant.

"The war casualties announced through November 7, 1944, comprise 88,000 Army

dead and 29,000 Navy dead, a total of 117,000 since the beginning of the war. By calculation from figures of the United States Public Health Service, there were from the beginning of 1942 through October, 1944, no fewer than 3,802,000 deaths—approximately thirty-two civilian deaths for each fatality in the services. Though this ratio is apt to diminish, civilian deaths will probably always be very much greater in number. Yet approximately only one half of the doctors were left for the home front.

When one compares only the number of deaths from accidents at home with those in the armed forces from combat, one finds, again on the basis of United States Public Health reports, that even the deaths from accidental causes in the United States, which are somewhat similar to war injuries, have been two and one half-times greater than those from combat.

What about the hundreds of thousands of seriously ill patients who are constantly in the civilian hospitals? The Army is proud of its record of low incidence of illness. Yet the Army medical officers have the finest physical specimens of young manhood in the country to deal with. Mortality from illness in that group should be lower than in any other. Moreover, they do not have to deal in any significant numbers with the greatest killers of all the causes of death—namely, heart disease, cancer and apoplexy, because, in general, those diseases occur after middle age. Also, in 1943 alone, there were approximately 2,500,000 births in this country. This represents a medical service almost exclusively handled by civilian doctors."

We are told that the British, the Australian and the Canadian armies have about half the number of officers per a

given number of soldiers of our Army "and there is universal testimony that the sick and wounded in those armies have received excellent attention . . . We have been spending our capital. It would be more precise to say that we have blown it in all at once."

Dr. Graham concludes his article: "The future of American medicine requires a realistic approach to the needs of the Army and Navy, as well as the home front, for doctors—and not slapdash doctors, but doctors trained in the thorough manner which has given to American civilian and military medicine a leading position in the world."

We feel sorry for the lads in Army and Navy uniforms we see studying medicine these days. We feel sorry for them now; we feel sorry for them when they will become Officers in the Medical Corps working alongside of men a little older who were properly trained; and we shudder to think of them when the war is over and they return to civilian practice and life.

Dr. Graham intimates that laymen in the Army and Navy have been responsible for all this chaos in medical education, but we have heard it told [always off the record] that the blame can also be directed to some of the big high-hats in the profession who seem to be able to give the answers even before they knew the figures. Any way you look at it the three-year wonders in medicine who have graduated and will graduate will comprise the most poorly educated and trained group of many, many decades.

The other day we were told by the assistant dean of a medical school that the Army requires 2,000 more physicians, and the Navy must have 8,000 more.

T S. W.



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# Original Articles

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## SURGICAL MANAGEMENT OF VASCULAR TRAUMA

CAPTAIN H. L. PUGH

MEDICAL CORPS, UNITED STATES NAVY

IN 1757, exactly ninety years after the death of William Harvey, William Hunter, older brother of John Hunter, first described arteriovenous aneurysm. Up through the years there appears to have been a fairly well sustained interest in trauma to and surgery of the vascular system. Each war has served to add a special impetus or boost to this interest. This was notably true of World War I, and is certainly true of the present war. The annals of medical and surgical literature have been enriched by many fine articles and reports upon the subject of vascular surgery, particularly during the last quarter of a century. At this very time, indeed, it is the rule rather than the exception to find an article on vascular surgery in practically any surgical periodical one may pick up.

A review of the literature on any subject preliminary to the preparation of a paper will usually do two things: First, it will add immeasurably to one's store of knowledge, and, second, it will reveal that a wholesome difference of opinion has prevailed upon various points in the minds of those who have individually contributed to that literature.

Prior to the entry of the United States into the current war, my personal experience with the management of vascular injuries had been practically nil. To date my experience comprises the handling of thirty cases in which arterial and arteriovenous trauma constituted the paramount disability.

It seems that when one comes to write upon a medical or surgical subject, whether his stimulus belongs to the category of

inspiration or provocation or whether he is just naturally possessed with a furor scribendi, there is a more or less generally accepted method of approach preliminary to the follow-through, all of which may be summed up in the one word—orthodox. Thus, having selected a title, a brief comment may be made by way of defining just what is supposed to be implied by that title and so, since my title is "Surgical Management of Vascular Trauma," it would appear right and proper to amplify this idea further by stating that I propose in the main, or primarily, to discuss traumatic arteriovenous fistulas or aneurysms, with some reference to etiology and to the symptoms and to the local and semi-local manifestations and to the systemic phenomena produced by these lesions, and lastly I shall come to a consideration of their surgical management. Such reference as I shall make to arterial trauma or accident *per se* will be secondary and for the sake of adding a little variety.

Suffice it, therefore, to say that in general arteriovenous aneurysms comprise two classes: first, true, and second, false; and since traumatic aneurysms belong entirely to the second class, the first, so far as this discussion is concerned, may be dismissed.

False aneurysms or aneurysm spurum occur usually as a result of direct injury, such as bullet, shell fragment, or stab wounds. One exception is the carotid cavernous sinus fistula, which may be caused indirectly by a fractured skull. The peculiar anatomy of the region makes this possible. This is the only place in the body where an artery is surrounded by a vein,



as has been pointed out by Penick.<sup>1</sup> We have in our series had one case probably belonging in the category with carotid cavernous sinus fistula. If the artery and vein communicate directly, such a short circuiting is classed as an aneurysmal varix or Potts aneurysm. If there is an intervening sac, a varicose aneurysm is said to exist. The time interval between the infliction or acquisition of a wound and the development of an aneurysm varies from immediately to weeks or even months.

*Pathogenesis.* The genesis and subsequent development of an arteriovenous fistula appears to be based upon fairly simple principles and will depend to some extent upon the character of the original wound. If, for example, a bullet or piercing instrument passes between an artery or vein lying in close proximity to each other, a nick in both vessels may result in the immediate shunting of the arterial blood into the vein, with very little extraneous hemorrhage and hematoma formation. In the majority of cases, however, there is spillage of a variable amount of blood, with a consequent hematoma which may be very well delineated by the surrounding structures or, on the other hand, this hematoma may extend along fascial planes or dissect into the soft tissues until it attains a considerable size. In any event, when the spread is ultimately arrested, a process of absorption and organization ensues and with the laying down of fibroblasts and connective tissue, a retaining wall or sac is formed. As time goes on this sac becomes lined with the same type of endothelium as constitutes the intima of the artery and its structure acquires a tough, elastic quality. Depending upon the resistance of the surrounding structures and also upon the nature of the break of the vessel walls, this sac can assume a variety of shapes. It may be single and symmetrical or it may be very asymmetrical and multilocular. Or there may be two more or less separate sacs, one communicating directly with the artery and the other with the vein. Numerous

collateral vessels usually communicate with the sac.

*Symptoms.* The subjective symptoms related to an arteriovenous aneurysm are reasonably constant in quality although the degree of such symptoms will vary depending upon the location and size of the lesion and upon possible concomitant nerve involvement. Pain of a tingling or burning nature extending along the affected extremity and numbness and a coldness of the extremity are the more common subjective symptoms.

*Signs.* The objective signs fall into two distinct classes: first, those elicited locally, and second, those regarded as systemic phenomena. Locally there are three classical signs which when present are pathognomonic of an arteriovenous aneurysm. They are (1) pulsating tumor, (2) thrill, and (3) bruit. The pulsation, when present, is characteristically expansile in type and is indicative of the presence of a sac. When a simple fistula exists without an intervening sac, a pulsation may not be felt. The thrill is a sensation imparted to the palating hand and is similar in quality to that produced by a purring cat. A bruit is an auscultatory sign and has been likened by Moorhead<sup>2</sup> to the buzz of machinery, the droning of bees, the whirr of a bird in sudden flight or the humming of a top. All three of these signs reach their crescendo during systole. They may all be reduced or made to disappear entirely by pressure on the tumor or proximal to it, provided, of course, the tumor or fistula is accessible. Position may likewise change the intensity of these signs. Pressure over or proximal to the tumor will moreover produce a slowing of the pulse. This bradycardia was recognized and described in 1890 by Branham, an American surgeon, and is generally referred to as Branham's sign, although at least one writer, Pratt,<sup>3</sup> refers to this manifestation as Paré's sign. Actually Nicaladoni is credited with having first described this finding in 1785.

The systemic phenomena produced by an arteriovenous aneurysm are several and

a contemplation of their cause constitutes one of the most fascinating aspects of this subject. As would be perfectly natural to expect, the chief changes wrought by this vascular short circuit are reflected in the circulatory system. A basis for an appraisal of the extent the arteriovenous fistula is affecting the general circulation will be afforded by a study of these systemic manifestations. Moreover, such a study will reveal a close interrelationship among and between the various phenomena and the *a priori* sequence becomes readily apparent.

To list these changes more in the order of their cause and effect relationship rather than in the order of their seriousness, we may as well begin with:

1. An accelerated heart rate. This, it may very logically be assumed, is due, to express it rather metaphorically, to a physiological call on the part of the affected extremity or region for more and better blood. In response to this call the heart beats faster.

2. Hand in hand with the accelerated heart rate and perhaps to some degree a consequence, the second systemic change presents itself, namely, that involving the blood pressure. The systolic pressure tends to become elevated and the diastolic to become lower, thus the pulse pressure is increased.

3. This coincides with and both directly and indirectly explains and is explained by the third systemic change or an increase of the cardiac output with a decrease in the stroke output.

4. An engorgement of the pulmonary vessels may be mentioned as No. 4 on the list of systemic manifestations or effects and the reason seems obvious.

5. The venous pressure and circulating time are increased. The reason is again obvious.

6. The demonstrability of an increased circulating blood volume has been claimed (Holman and Shen<sup>4</sup>). This, however, was not confirmed by Reid and McGuire.<sup>5</sup> In any event, no more than academic interest,

it would seem, need be attached to this latter point. However, that the several cardiovascular manifestations do lead to a very important consequence is inevitable and natural.

7. This consequence is that of damage to the heart itself—cardiac dilation or hypertrophy. This, it can be said without reservation, is the most deleterious systemic effect, complication or sequel of arteriovenous fistulas. While usually regarded as a late manifestation it may come on amazingly early. Mason et al.<sup>6</sup> reported an arteriovenous aneurysm which ended fatally on the fourth day following a stab wound in the supraclavicular fossa. The cause of death as revealed by clinical observation and autopsy was cardiac decompensation. The explanation for damage to the heart can be found wrapped up in the several circulatory phenomena enumerated, though if reduced to simple terms the explanation may be said to be fundamentally twofold: First, the shunting of arterial blood into venous channels through the fistulous opening leads to an overfilling and dilation of the right side of the heart. It follows naturally that the larger the opening, the larger the amount of blood shunted, the greater the overfill and the more rapid the dilatation. The second factor in cardiac hypertrophy (and actually this factor is more conducive to hypertrophy than to a simple dilatation) is that of overwork (McGuire<sup>7</sup>). Because of the set of circumstances responsible for the accelerated rate, the elevated systolic pressure, the increase in the cardiac output, etc., the heart is laboring under difficulties and is working overtime day and night. Here again the size and location and duration of the fistula are important considerations.

8. Early evidence of cardiac damage due to arteriovenous aneurysm can be detected by an electrocardiographic tracing.

*Semi-local Changes.* Still related to the circulation but separate from the manifestations involving the heart, certain changes occur locally or in the immediate

vicinity of an arteriovenous shunt. The most important of these changes is the establishment of a collateral circulation which in some instances is indeed striking. That the establishment of such a circulation is stimulated by the presence of a fistula far and above that which occurs following the ligation of the main trunk of an artery was pointed out by Dr. Mont Reid<sup>8</sup> and is a well established fact. This in itself poses a phenomenon more amazing perhaps than any other associated with the whole subject of arteriovenous aneurysm or fistula. The most plausible explanation for this interesting truth is, so far as I have found in the literature, offered by Dr. Emile Holman<sup>4</sup> who refers to Dr. Reid's early work. The most important factor, according to Holman, appears to involve the element of lessened resistance to the flow of blood in the area adjacent to and surrounding the site of the fistula. Normally considerable resistance is offered the flow of blood by the capillary bed through which it must pass. Because there is a fistula, the capillary bed is bypassed and the resistance to the flow of blood is lessened, and because the resistance is lessened in the arterial tree a greater amount of blood is attracted to the site through all available channels including the collateral vessels. It is likened by Holman to an attempt at appeasement of the thirst of the fistula by an opening up of all avenues leading to it. This is particularly marked if the fistula is large. This lessened resistance and increased flow of blood incident to the abnormal communication undoubtedly accounts for another extraordinary development and that is the dilatation of the artery distal to the fistula (Holman<sup>9</sup>). The proximal artery may also show thinning and dilatation and the size and length of the extremity may increase (Reid and McGuire<sup>5</sup>). The several latter factors are by no means constant and will depend in no small measure upon the duration as well as the size of the fistula.

Other variable manifestations contingent upon factors too obvious to warrant de-

tailed discussion are: (1) Venous stasis leading to marbling of the skin overlying the region of the fistula; (2) increasing varicosities; (3) trophic changes; (4) associated nerve paralysis, and (5) limitation of joint motion. This is particularly prone to accompany a popliteal aneurysm and is almost always due to a concomitant injury to the joint or the peri-articular structures by the same agent which caused the aneurysm rather than to the presence of the aneurysm *per se*.

*Treatment.* We now come to the phase of the subject about which most of the expressed difference of opinion exists, namely, the treatment. But before entering upon a discussion of the determinate or specific treatment of the aneurysm itself, it would seem fitting and timely to comment upon certain general principles which by reason of either an indirect or direct influence may very appreciably effect the complexion of the situation.

1. In this category would come the *treatment of shock* in acute recently injured cases and mention is made of this for the sole purpose of calling attention to the fact that in shock the blood pressure is lowered and in vascular trauma ischemic gangrene is a prime threat. A lowered blood pressure and lowered temperature incident to shock tends further to predispose to tissue death in the involved extremity. Therefore, it is of especial importance to guard against and combat shock.

2. *Keep the patient warm.* Warmth encourages vasodilatation. Beware of hot water bottles and heat cradles. Impairment of circulation leads to increased vulnerability of the part to heat or trauma from pressure. It is extremely easy to blister an extremity in which the threat of gangrene impends by the careless use of heat. It has been moreover contended that heat increases metabolism in an area the circulation of which is already incapable of meeting the local demand, therefore, on this score heat is bad. Cold causes vasoconstriction and so is that bad. In any event, common sense dictates warmth

within reason. Alcohol is a vasodilator and so predicated is sometimes prescribed. It will do no harm and may do good.

3. The *extremity should be kept elevated* but not excessively so. The best height should be determined by the position of maximum comfort to the patient. This will usually be found at a level slightly lower than that of the heart. The extremity should be allowed to rest on soft pillows. Pressure or trophic ulcers are always a definite menace.

4. It is a well established fact that *injury to a large blood vessel is accompanied by a pronounced spasm*, not only of the injured vessel but also of the associated collaterals. If it were not for this fact, death from hemorrhage would be far more common (Ochsner<sup>10</sup>). The sympathetic nervous system controls this spasm. An interruption of the sympathetic influence by either the injection of procaine or alcohol into the nerve chain or surgical section of its ganglia will eliminate and make such spasm impossible. Based upon this concept, plus the repeated observation of actual and striking results, the interruption of the sympathetic nervous system by either injection or section has become an almost routine adjunct in the management of vascular trauma in some clinics, particularly that of Dr. Alton Ochsner of New Orleans. We have not resorted to section here but have employed injection of procaine in either cervical or lumbar sympathetics in a number of cases. There is no question as to the efficacy of this measure.

5. The *cessation of the arterial circulation* will lead to dry gangrene. It is a cardinal surgical principle to keep dry gangrene dry, therefore, avoid wet dressings.

6. The importance of the *care of the local wound* should not be overlooked. If it is infected, treat the infection according to sound surgical principles and do not attempt repair of an aneurysm until every evidence of infection has definitely subsided.

7. When operating, *employ the most meticulous aseptic technic*. A successful out-

come will depend upon the avoidance of sepsis as a first requisite.

Upon reviewing the literature relative to the definitive treatment of arterio-venous aneurysm as it has appeared in the various surgical periodicals and upon consulting a number of text books, one must gain the impression that the fundamental concepts and doctrines preached vary, depending upon several factors, the chief among which are whether or not the author is writing an article in conjunction with a series of patients he has personally treated and is reporting upon, or whether the author is writing a text book or section thereof.

Generally speaking, the author of the article which supplements the report of a group of cases will emphasize a single, clear-cut method which produced satisfactory results in his series. The author of the text book will describe a number of methods and will in all likelihood adopt a conservative or middle of the road attitude. On two points in particular it is startling to note how at variance is the concept laid down by several text book authors, with that of authors who report upon a large number of personally conducted cases. I refer in the first instance to the matter of ligating or not ligating the accompanying vein when a large artery is ligated. Hermann and Reid,<sup>11</sup> for example, stress the importance of ligating the accompanying vein: "We cannot too strongly condemn the procedure of simple ligation of the involved artery at a point proximal to the fistula." Reid and McGuire<sup>5</sup> further amplify this contention:

"An untold number of limbs have become gangrenous and have had to be amputated because of the simple proximal ligation of the artery. It is far more dangerous than the ligation of an artery for an arterial aneurysm for the shunt or spillway remains and there is no longer enough arterial force to push the blood beyond it."

Thorek<sup>12</sup> stresses the importance of preserving the vein: "In important vessels, ligation of the vein carries with it the danger of gangrene, therefore preservation

of the vein in arteriovenous aneurysm plays a signal role."

The second matter about which a difference of opinion is conspicuous entails a condemnation by some of quadruple ligation and excision of the sac (Warbasse and Smyth<sup>13</sup>): "The vessels may be ligated above and below the sac and the sac excised. This is usually an unnecessary amount of traumatism and is rarely indicated. This quadruple ligation usually constitutes an unnecessary sacrifice of vessels and should when possible be substituted by clamping the vessels, excising the sac and suturing the vessels from within." Others, notably Moorhead,<sup>2</sup> Holman,<sup>16</sup> Herrmann and Reid,<sup>11</sup> and Waugh and Neel,<sup>14</sup> have repeatedly stressed the applicability, the comparative simplicity, and the gratifying results obtained upon quadruple ligation and excision.

The second factor which appears to have a bearing upon the prevailing trend in the management of arteriovenous aneurysm is the medical school which the author attended or section of the country or world wherein he has practiced. New Orleans, for example, has for long been thought of as an oracle on vascular surgery. This, of course, has been due to the great influence there of the illustrious Dr. Rudolph Matas. His proteges are many and in many respects are imbued with similar ideas, all emanating from Dr. Matas. In New England there is another school of thought not necessarily different but nevertheless separate, centered around Harvard and the Lahey Clinic. In New York and Philadelphia there are in-between schools which can claim a number of great progenitors, including Dr. Moorhead and the immortal John Chalmers Da Costa. In the Midwest, Dr. Crile's Clinic in Cleveland, the Mayo Clinic at Rochester and that of the late Dr. Mont Reid at Cincinnati, have for long radiated the highest surgical concepts to the four corners of the earth. On the west coast, I know of no one who has contributed more to the advancement and solidification of ideas relative to vascular

surgery than Dr. Emile Holman, late of Stanford University and now a captain in the Medical Corps of the United States Navy. For those who may still believe that the last word has not been spoken until Europe has been heard from, reference may be made to Paul Delbet of France. As long ago as 1889, when modern surgery was in its early infancy, Delbet, after having studied 695 cases of arteriovenous aneurysms, recommended that all indirect methods which at that time enjoyed great popularity be discarded, and that ligation and extirpation of the sac be substituted therefor.

The third factor which will be seen to influence in no small measure the principles and practices advocated in the treatment of arteriovenous trauma will be contingent upon whether the proponent is a civil or military surgeon. If civil, the inclination will likely be toward conservatism and the more involved methods. If military, the inclination will be toward early operation, a simple method and expeditious conclusions.

The many surgical procedures which lend themselves to the treatment of the various types of arteriovenous aneurysms and fistulas have been repeatedly described in many surgical magazines, systems of surgery and text books, and for the purpose of this paper need not be reviewed. The essential objective is that the passage of blood from the artery to the vein through a fistula be completely and permanently prevented.

Granted that a few arteriovenous fistulas and traumatic arterial aneurysms may disappear spontaneously or under some physiotherapeutic regimen such as Vanzetti's method, certainly the great majority will not, and such conservatism is not likely to be compatible with the exigencies of the military service. On the other hand, too early surgical intervention is definitely fraught with risk. It must be agreed that a minimum of two or preferably three months must be allowed to elapse in order that the collateral circulation will have had a

chance to develop. Undoubtedly this will require less time in young, vigorous men than in older individuals.

There are certain methods of testing the collateral circulation published by Dr. Matas in the *Journal of the American Medical Association* many years ago, and are listed under Treatment of Aneurysms in Dr. Da Costa's text book of *Modern Surgery*.<sup>15</sup> Any of these or other methods may be employed.

Suffice it in any event to say that in the series of twenty odd cases done at this hospital, not more than six months elapsed in any case (save one) and much less in several between the infliction of the wound and the operation for vascular trauma. A quadruple ligation with excision of the fistula was done in twenty cases of arteriovenous aneurysm. Paravertebral injection of the lumbar sympathetics or cervical sympathetics was employed in nineteen cases. There was no incident of gangrene of the extremity in nineteen cases. One case, however, (Case E.B.L.) promptly developed gangrene despite all efforts to forestall it and amputation of the leg above the knee was necessary. The arteriovenous fistula was of two and a half years' standing in this case. Certain extenuating circumstances described in the case report undoubtedly contributed to this tragedy. In one case of popliteal arteriovenous aneurysm in which the artery alone had been ligated, there was a grave threat of gangrene, however, prompt ligation of the vein was followed by an immediate improvement of the circulation and gangrene was averted. In one patient in whom the axillary and axillary circumflex arteries had been severed by metal fragments, ligation of the arteries alone was promptly followed by a dry gangrene which later necessitated an amputation of the arm above the elbow. This case is exclusive of the series of twenty arteriovenous aneurysms above referred to, since in this instance the trauma involved only the large arteries. It is believed that this arm might have been saved if the axillary vein had

been ligated concurrently. This, of course, is purely speculative and it might be added here that a concomitant gross trauma of the surrounding soft tissues is an additional predisposing factor to gangrene of the extremity below such trauma. This type of tissue damage obtained in the case in question.

Recovery from such disability as could be ascribed to the arteriovenous aneurysm was complete in every case. All returned to full or limited duty, unless a separate and distinct additional encumbrance forbade.

The experiences of those who have actually had occasion to deal first hand with an appreciable number of cases and certainly the experience of those who are today handling an increasing number incident to the war tends more and more to substantiate the opinion shared heartily by this writer, that quadruple ligation and excision of the involved segment is the treatment par excellence for arteriovenous aneurysms or fistulas. However, that this procedure should not be resorted to with impunity and that the development of gangrene and the loss of a limb may supervene is a fact to which we can unreservedly attest.

The futility and disadvantage of using a tourniquet in the surgical management of arteriovenous aneurysms has been spoken of by a number of writers—Reid and McGuire and others. Certainly in our experience the control of bleeding even after a quadruple ligation has been done has at times been distinctly difficult. To obtain hemostasis so perfect as to permit detailed and methodical repair of these lesions has appeared impossible.

In a recent article by Dr. Emile Holman<sup>16</sup> three notable points have been stressed: One is the feasibility of or advantage to be gained by resection of the clavicle when an operation upon the subclavian vessels is necessary. Another is the importance of gaining control of potentially dangerous hemorrhage by exposing and temporarily arresting the flow of blood through the

common and external iliac vessels when operating upon a lesion in the femoral area. A practical method of exposing the iliac vessels extraperitoneally is described by Dr. Holman. A third matter stressed in this article is the rationale for ligating the main artery just distal to an important collateral proximally and just proximal to an important collateral distally. In other words, the avoidance of dead ends or functionless segments is regarded as important.

We have not resected the clavicle in any of our subclavian fistulas but we have exposed and placed slings of rubber dam tubing around the iliac vessels in four of our femoral aneurysms, and we have observed the principle of ligating near collaterals where this has been possible.

The danger of ligating a large vessel in elderly patients with damaged hearts has been spoken of by Reid and McGuire<sup>5</sup> and the advisability of gradually accustoming the heart to a permanent closure of the fistula by repeatedly occluding the vessel proximal to the fistula, by repeated digital compression, has been recommended. The preliminary ligation of the proximal vein or both proximal and distal veins is advantageous and is sometimes warranted.

Two fatalities occurred in our series of arterial accidents and arteriovenous trauma; the first in an elderly patient who died of a pulmonary embolus after an embolectomy had been successfully performed on the first portion of his axillary artery, the second in an elderly patient who developed a rupture in a femoral artery with consequent large hematoma formation. In the latter case death ensued shortly after the ligation of the femoral artery proximal to the rupture.

What about the re-establishment of continuity of arteries by end-to-end anastomosis? It sounds good and looks all right in pictures, but the cases in which it could be even so much as attempted are few and far between. Those whom I regard as the best authorities on the subject of vascular surgery say, "Don't try it; it won't work."

Whether or not absorbable or non-

absorbable ligatures are used seems to make not a great deal of difference. Only one of our patients hemorrhaged secondarily. This occurred after one week in a patient in whom early operative intervention was regarded as imperative (due to pain and steady increase in the size of the hematoma), despite the known existence of infection and much soft tissue damage and death. Following secondary ligation and leaving the wound open, the patient went on to an uneventful recovery and has a good leg.

#### CASE REPORTS

**CASE I.** The patient, age twenty-one, was admitted October 11, 1942, with a lesion in the right popliteal area due to shell fragment wound. This had existed two months and was an arteriovenous fistula between the popliteal artery and vein. Principal symptoms and signs were: Expansile pulsation, thrill and bruit over the right popliteal area; irregular granulating wound of the right popliteal area. Motion of right knee was limited to 50 per cent of normal. Operation was performed on October 28th. Treatment: Excision of the arteriovenous fistula with quadruple ligation was carried out and the patient was cured.

*Comments.* This patient revealed readily demonstrable Branham's sign, but there was no demonstrable cardiac enlargement. The patient received paravertebral injections of his right lumbar sympathetics with striking results. Motion of right knee joint was gradually regained; however, full function was not completely restored until approximately eight months had elapsed. He was discharged from the hospital well.

**CASE II.** The patient, age fifty-two, was admitted Feb. 21, 1943, with a lesion in the right axilla, received from a high pressure test line explosion one hour previously. He had suffered a severance of the right axillary and right circumflex arteries. The principal symptoms and signs were terrific hemorrhage from gaping wound of the right axilla. Operation was performed on Feb. 21, 1943, March 23rd, April 17th and May 13th. These consisted of (1) axillary circumflex and axillary artery ligated; (2) amputation above elbow;



(3) removal of metal fragment; (4) removal of metal fragment. The patient's life was saved; however, amputation of the right arm above the elbow as a result of dry gangrene was necessary.

*Comments.* Two factors may have contributed to the inevitable loss of this patient's arm: (1) severance of the axillary circumflex artery as well as the axillary artery may have fatally impaired the collateral circulation; (2) there was extensive and severe soft tissue damage about the right shoulder and axilla. This, aside from the vascular trauma, is distinctly conducive to failure of adequate circulation. In any event, it is believed that the chance of saving this arm would have been much better if the axillary vein had been ligated at the same time as the artery.

CASE III. The patient, age twenty-one, admitted December 23, 1943, had a gunshot wound in the mid-section of the upper right arm. This had occurred three and one-half months before. It was an arteriovenous aneurysm of the brachial artery and vein.

Examination at time of admission revealed complete paralysis of his median and ulnar nerves on the right. There was a loss of both motor and sensory senses. There was a mild causalgic burning of his right palm and anesthesia in the area of the medial, anti-brachial cutaneous nerve on the right side. A pulsating tumor about the size of an English walnut was readily demonstrable in the mesial aspect near the mid-section of the right arm. A thrill and bruit characteristic of an arteriovenous aneurysm were readily elicited over this tumor. A positive Branham's sign was readily demonstrable. X-ray revealed no evidence of cardiac enlargement.

On March 4, 1944, an arteriovenous aneurysm was excised from his brachial vessels and quadruple ligation was done. Pains were taken to ligate the brachial artery just distal to the superior ulnar collateral proximally and just proximal to the inferior ulnar collateral distally. A neurolysis was done upon both median and ulnar nerves, both of which were densely involved in the scar tissue surrounding the aneurysm. The median nerve had been nicked to about its mid-diameter, the ulnar nerve was markedly narrowed. The continuity of both

trunks, however, was still intact. (Fig. 1.) The patient was cured.

*Comments.* The wound healed by first intention and the circulation in the hand and arm improved almost immediately. However, causalgic pains persisted in the hand. This responded in a most gratifying manner to the injection of the cervical sympathetics with 1 per cent procaine. Normal sensation and function were slowly returning to this man's right hand and arm when he was returned to limited duty four months postoperatively.

CASE IV. The patient, age twenty-one, was admitted December 23, 1943, with a gunshot wound of the right femoral area. This was of two months duration. It involved an arteriovenous aneurysm between the right femoral artery and vein. Principal symptoms and signs were marked pulsation over the right femoral and inguinal area; loud bruit and pronounced thrill were also present over this area. The patient complained of numbness and a tired feeling in his right leg.

On January 11, 1944, the abdomen was opened, right iliac artery and vein were exposed, and soft rubber slings were placed around these vessels as a safety precaution. Through a second incision below Poupart's ligament, the femoral artery and vein were exposed and on arteriovenous aneurysm was demonstrated just distal to the profunda branch of the femoral artery and the junction of the saphenous vein with the femoral vein. The segment containing this aneurysm was excised and quadruple ligation was done. The patient was cured.

*Comments.* Considerable bleeding was encountered from collaterals connected with the excised segment, despite the fact that the artery and vein were occluded with soft rubber slings proximal to the lesion. It was difficult in this case, as has been true of our entire series, to understand how bleeding is ever sufficiently controlled to permit definitive and detailed plastic repair of vessels at the site of an arteriovenous aneurysm. The circulation in this man's leg appeared to improve immediately following operation. He received 1 per



cent procaine injections of his right lumbar sympathetics daily for four days postoperatively. Postoperative convalescence

cles was noticeable upon walking. There was a well defined palpable mass in his popliteal area which pulsed and produced a pronounced

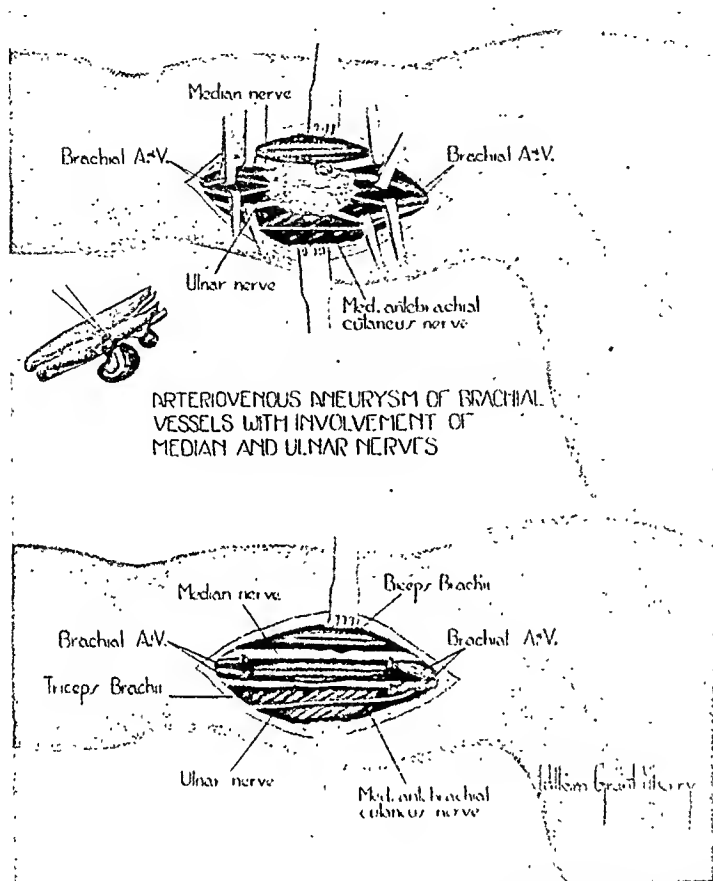


FIG. 1. Arteriovenous aneurysm of brachial vessels treated by quadruple ligation and excision. Note nick in median nerve and thinning of ulnar nerve.

was uneventful and two weeks following operation, the patient was up and around and experienced no symptoms other than moderate fatigability of his right leg. Chromic gut absorbable sutures were used throughout for ligation of large vessels in this case.

**CASE V.** This patient, age twenty-one, was admitted on December 23, 1943, with a gunshot wound of the left popliteal area. Its duration was two months. It consisted of an arteriovenous aneurysm between the popliteal artery and vein. The chief symptom was that of numbness in his left leg from the knee down, also tingling and a feeling of coldness in his foot. He was unable to straighten his knee entirely, and undue fatigability of his calf mus-

thrill. Auscultation revealed a loud bruit. Here was a classical picture of an arteriovenous aneurysm.

A quadruple ligation was done upon the popliteal vessels and the aneurysm was excised on January 18, 1944. A false aneurysmal sac the size of an English walnut was present. The usual surprising degree of bleeding from collaterals attached to the sac accompanied this operation despite the fact that the artery and vein were ligated both proximally and distally before excision of the aneurysm was attempted. The patient was cured.

**Comments.** The immediate improvement which followed this operative intervention was most gratifying. Twenty-day No. 2 chromic catgut was used for ligatures

on large vessels. This patient returned to duty symptom free.

CASE VI. The patient, age twenty, was admitted December 23, 1943, with a gunshot wound of the right axilla received, two months previously. It consisted of an arterial aneurysm of the right axillary artery.

At the time of admission there was a small, well healed bullet wound of entry in the anterior axillary fold and a somewhat larger but likewise well healed wound of exit in the posterior axillary fold. A pulsating tumor about the size of a hen's egg was readily demonstrable in his right axilla, however, no thrill was perceptible nor could a bruit be heard. It was, therefore, considered likely that this was a simple false aneurysm, due to an interruption of continuity of the wall of the axillary artery and that a true arteriovenous fistula did not exist. At operation the right subclavian artery was ligated and divided at the triangle of election.

The patient experienced immediate relief from the annoyance of the pulsation in his right axilla following operation and he thought he had more feeling in his hand and arm. How much of this was psychic is, of course, conjectural.

*Comments.* Neurological examination revealed lower brachial plexus paralysis (biceps, triceps, flexors and extensors of his arm, and all the hand muscles). The paralysis was worse distally, with complete wrist drop and total paralysis of all the finger movements. The median nerve function in the hand was more affected than the ulnar. Only slight atrophy of forearm muscles was present. There was sensory loss only in median nerve distribution. The hand and finger nails were dry and scaly. It was considered conceivable that this man's paralysis might be in part or wholly due to pressure of the aneurysm upon the nerve trunks in the axilla. However, the paralysis of this patient's arm and hand failed to improve appreciably following ligation of the aneurysm, although there was no further evidence of disturbance of circulation in this extremity and no evidence of recurrence of pulsation

in the axilla. The aneurysm, therefore, is considered to have been cured.

As a means of correcting this patient's wrist drop the flexor carpi radialis and the flexor carpi ulnaris were transferred from the volar to the dorsal aspect of the wrist. The flexor carpi radialis was hooked onto the long and short extensor and abductor muscles of the thumb, and the flexor carpi ulnaris was hooked on to the common extensors of the fingers. A good functional result was obtained. This patient was surveyed to limited duty.

CASE VII. This patient, age nineteen, was admitted December 23, 1943, with a gunshot wound in the right subclavian region, of two months' duration. It was an arteriovenous aneurysm. Principal symptoms and signs were numbness and weakness of the entire right arm and hand; hyperesthesia and hyperalgesia present over the median nerve distribution. A pulsating aneurysm was plainly visible and palpable; a loud bruit and marked thrill were present in the right subclavian region mesial to the axilla.

Treatment consisted of (1) right subclavian artery ligated; (2) quadruple ligation, axillary vessels—arteriovenous aneurysm of the first portion of the axillary vessels excised. The patient was cured.

*Comments.* The right subclavian artery was ligated preliminarily through the triangle of election. The artery was divided between ligatures and nothing further in the way of surgery was done. Further surgery was contemplated, depending upon whether the circulation in the arm was improved or further impaired by this ligation. It was thought that this aneurysm might well be a traumatic arterial aneurysm rather than an arteriovenous fistula, and that simple ligation of the artery might suffice. The state of the circulation in his hand did not appear to be appreciably affected one way or the other. Certainly it was not made worse. The bruit, thrill and pulsation disappeared and remained absent for about a week, when a slight thrill again became perceptible to the palpating hand. The subjective symp-

toms of pain, numbness and cold feeling largely disappeared from the patient's arm and hand, temporarily. However, after about a week the whole symptom complex had become re-established.

On February 10, 1944, under general anesthesia, a well defined arteriovenous aneurysm of the first portion of the axillary vessels was exposed through a transverse incision just below the clavicle. The involved segment was excised and a quadruple ligation was done. A sac about the size of the distal phalanx of a man's thumb was found extending inward and was densely adherent to the posterior cord of the brachial plexus and to the lateral and middle cords. The patient's convalescence from this operation was uneventful, the subjective symptoms disappeared entirely from his arm and but for some inordinate fatigability, function of his arm had been completely restored within a month. He was discharged to duty well.

**CASE VIII.** This patient, age nineteen, was admitted December 23, 1943, with a gunshot wound of the left popliteal area of three and one-half months' duration. It consisted of an arteriovenous aneurysm of the popliteal vessels.

The patient sustained a fractured left femur as a result of machine gunfire. His left leg was encased in a plaster of paris cast with hip spica which he was wearing at time of admission to this hospital. Upon removal of this cast, a pulsating, tumor-like mass the size of a lemon was readily apparent in the popliteal space. A characteristic thrill and bruit were unmistakably demonstrable. There was some dilatation of the superficial veins with marbling in the region of the knee. Pressure over the vessels of the leg proximal to the popliteal space produced a slowing of the pulse—a typical Branham's sign. Chief subjective symptoms were a numbness and a tingling sensation in the left foot and leg.

Quadruple ligation and excision of popliteal aneurysm were performed on March 4, 1944. The popliteal nerve was densely bound to the aneurysmal sac by fibrous adhesions. This nerve was carefully preserved intact. The patient was cured.

**Comments.** The subjective symptoms promptly subsided following operation.

Paravertebral injection of the left lumbar sympathetics with 1 per cent procaine solution was done daily for the first four post-operative days. The foot promptly assumed its normal color. This patient's convalescence was uneventful except for the fact that preternatural mobility at the site of the fracture of his femur increased, indicating a separation of the partially healed fragments. His leg was replaced in a cast and treatment of his fracture was resumed.

**CASE IX.** The patient, age twenty-five, admitted April 1, 1944, suffered a knife wound in the posterior aspect of the leg, a short distance below the popliteal space. This man is alleged to have fallen accidentally and plunged a boning knife through the upper extremity of the calf of his leg one hour before admission. There was a complete severance of the popliteal artery. The principal symptoms and signs were cyanosis, coldness, and pain in the left foot and leg.

Treatment consisted of ligation of the bleeding vessels. Paravertebral 1 per cent procaine injections of his left lumbar sympathetics were begun the day of admission and were continued daily for one week. Intermittent use of a Pavex vacuum boot was begun on the day following admission and was continued for a period of ten days. Despite these measures, plus a number of transfusions, his left foot remained cold and livid, then began to assume the classic appearance associated with gangrenous changes. A severe infection developed in his leg which required incision and drainage. A markedly elevated temperature was definitely modified by the use of penicillin, however, the necessity for amputation became obvious. A guillotine type amputation was, therefore, done at the site of election, approximately six inches below the tibial tubercle. His convalescence following amputation was uneventful. The patient was cured but with loss of a leg.

**Comments.** It is a well recognized fact that sudden interruption of continuity and ligation of the large vessels of an extremity is more conducive to gangrenous changes than the ligation of similar vessels for an arteriovenous fistula. However, in this case it was never known whether the popliteal vein was actually severed and ligated. It is considered likely that this was not the

case and that the chance of saving this leg would have been much better if the popliteal vein had been ligated concurrently with the popliteal artery. The super-vention of a severe infection in the wound, moreover, contributed in an inestimable measure to the fatal impairment of circulation in this patient's leg.

**CASE X.** This patient, age nineteen, was admitted to the hospital April 20, 1944, with a lesion of the right wrist. This wrist had been pierced by a piece of sharp wire one year previously, and the patient suffered with an aneurysm of the radial artery.

About one month after sustaining a puncture wound of his wrist by a piece of wire, the patient noticed a small, pulsating mass over the radial artery. This gradually became larger for a few months and has been stationary for the past four to five months. Aside from a tight, uncomfortable feeling in his wrist and the awareness of a pulsation, the patient experienced no subjective symptoms. Examination revealed a well defined pulsating tumor, the size of an English walnut, on the volar aspect directly over the radial artery.

Aneurysmorrhaphy was carried out on May 13, 1944. The radial artery was exposed and a fusiform aneurysmal sac, the size of a small English walnut, was demonstrated. This sac was opened, redundant tissue was excised, and the continuity of the artery was preserved by reconstructive surgery. Atraumatic fine chromic gut was used as suture material. The aneurysm was cured.

*Comments.* A weak radial pulse was palpable at the site of the aneurysm at the time of the patient's discharge from the hospital one month following operation.

**CASE XI.** This patient, age eighteen, was admitted to the hospital August 17, 1944, with a congenital lesion of the right vertebral artery and vein. This had been present ever since patient could remember. There existed an arteriovenous fistula between the right vertebral artery and vein.

Principal symptoms and signs were pulsation, thrill and bruit, in the right occipital region. This patient has experienced tinnitus in the right ear, and a buzzing sensation in his head along with occipital headache for a period of years.

Treatment on August 29th consisted of excision of the segment containing the arteriovenous fistula, with quadruple ligation of vessels. The patient was cured and symptoms of headache, tinnitus, and buzzing were all relieved by operation.

*Comment.* An incision four inches in length was made diagonally in the left occipital region and by dividing part of the fibers of the sternocleidomastoid, the trapezius, and the splenius cervicis muscles, the triangular area bounded by the obliquus capitis inferior, the obliquus capitis superior and the rectus capitis posterior major muscles, the aneurysm was exposed. By careful dissection this aneurysm was demonstrated to involve the vertebral artery and its accompanying vein. The segment containing the aneurysm was excised and the vessels ligated proximally and distally. This lesion involved that portion of the vertebral artery which lies against the base of the skull immediately before it enters the foramen magnum.

**CASE XII.** The patient, age twenty, was admitted on August 4, 1944, with a gunshot wound of the femoral vessels. (Figures 2A and 2B.) This wound was received two and one-half years previously. An arteriovenous fistula between the femoral artery and vein existed.

Principal symptoms and signs were pulsation, thrill and bruit in the right groin; marked fatigability of the right leg; intermittent claudication; scar marking point of entry of a rifle bullet over anteromesial aspect of the right thigh, 1 inch below Poupart's ligament.

Treatment consisted of (1) excision of the arteriovenous fistula, with quadruple ligation of the femoral vessels, also ligation of profunda artery and saphenous vein; (2) exploratory incision, right popliteal space, and aspiration of the right popliteal artery; (3) amputation of the right leg.

Impending gangrene became manifest during the first twenty-four hours following excision of the arteriovenous fistula and ligation of vessels. Despite every effort to forestall this calamity, including daily paravertebral injection of the lumbar sympathetics, the use of alcohol systematically, the use of spinal anesthesia and Pavex boot, a line of demarca-

tion became established in the neighborhood of the knee joint and the lower leg became frankly gangrenous, making amputation imperative.

extenuating circumstances we have the following to offer: A year subsequent to the gunshot wound in the right femoral region

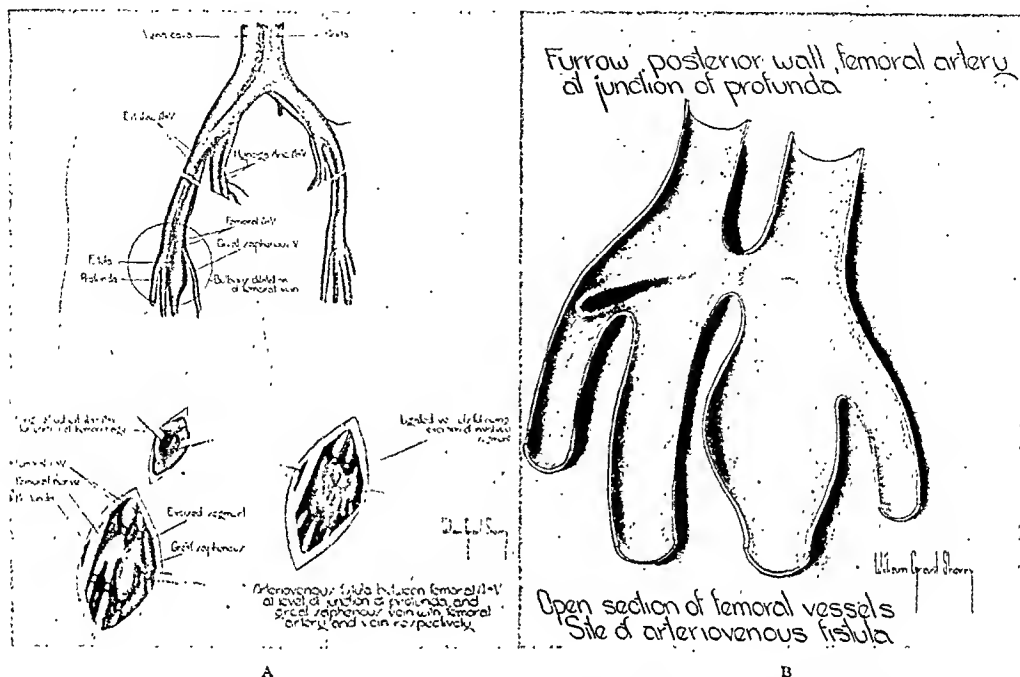


FIG. 2. A, arteriovenous fistula, femoral vessels. This fistula, the result of a gunshot wound, had become established at the level of the junction of the profunda artery and great saphenous vein with the femoral artery and vein, respectively. It was impossible owing to the location and peculiar arrangement (see Fig. 2B) of this fistula, to preserve continuity of either the profunda artery or the saphenous vein. All of the great vessels immediately adjacent to the fistula were ligated and the intervening segment excised. This patient promptly developed gangrene of his lower extremity which ultimately required amputation above the knee. B, this drawing illustrates the damage to the profunda artery which made it impossible to maintain continuity of this vessel. When the femoral vessels were free from their bed there was profuse bleeding from the profunda artery through the break in its wall, as illustrated.

**Comment.** The result in this case was dramatically tragic and while there were certain known circumstances which were regarded as unfavorable, the operation in itself was no more radical than had been done on two other patients of our series. In this case the arteriovenous fistula communicated with the femoral artery and vein at a site exactly opposite the junction of the profunda with the femoral artery and slightly below the junction of the saphenous with the femoral vein. An effort was made to preserve the profunda artery and saphenous vein but the location of the fistula was such as to make this accomplishment impossible, therefore, the involved segment was excised and the standard quadruple ligation was done. As

and one and a half years prior to the operative intervention instituted here, the patient sustained a considerable wound of his right thigh due to coming in contact with a buzz saw. This may well have interfered with certain important collaterals. Moreover, on two different occasions following the gunshot wound of the thigh, this boy had received gunshot wounds of his leg below the knee from a .22 caliber rifle. One of these wounds may have damaged the anterior tibial, the other one the posterior tibial artery. These several circumstances are believed to have together constituted a very real contributing factor to the inadequate circulation which prevailed in this leg following the ligation of the main vessels. There was in any event

one observation which should have received more consideration. That was the fact that no positive Branham's sign could be demonstrated on this patient preoperatively. This indicated that the fistula was small and because the fistula was small, the period of its duration notwithstanding, it was insufficient to produce the abundant collateral circulation usually associated with an arteriovenous fistula.

**CASE XIII.** This patient, age twenty-nine, was admitted to the hospital on September 29, 1944, with a gunshot wound of the left axillary artery (Fig. 3), sustained one hour previously. He suffered a severance of the axillary artery immediately below the clavicle by a .45 caliber bullet.

Principal symptoms and signs were profuse arterial bleeding from the wound of entry below the clavicle; loss of function and sensation in the left forearm and hand; a large hematoma beneath pectoralis major muscle and shock.

Ligation of the subclavian artery in its third portion was carried out. Hemorrhage was arrested. Circulation in the arm was preserved through the anastomosis of the branches of the thoracocromial trunk immediately below the point of severance and the thyroid-cervical trunk above the level of ligation. Function of the arm remains impaired due to damage of the brachial plexus.

**Comment.** This patient was brought to the hospital in a markedly exsanguinated condition one hour following receipt of a gunshot wound from a .45 caliber pistol which severed his left axillary artery. The bullet entered the left shoulder at the junction of the middle and outer third of the clavicle at a point immediately below the clavicle and immediately over the axillary artery. It passed inward, backward and downward and emerged through the triceps muscle on the posterior aspect of the arm approximately at the level of the upper and middle thirds of the humerus. There was no fracture of any of the skeletal structures about the shoulder. This patient's life was undoubtedly saved by the prompt action of a hospital corpsman who stuck his finger into the wound of entry and held it against the bleeding

artery until the patient arrived at the hospital. The subclavian artery was ligated through the triangle of election and im-

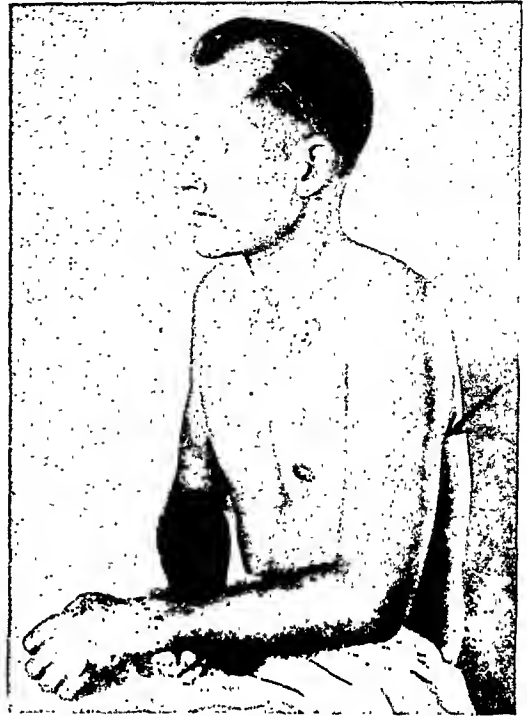


FIG. 3. Picture showing wound of entry and exit, .45 caliber bullet, also scar, supraclavicular region, marking site of incision for ligation of the left subclavian artery. The circulation in this arm was adequate. However, the damage done to the brachial plexus resulted in complete paralysis below the elbow.

mediately following, the hand was completely cyanotic and cold. However, within twelve hours the circulation had apparently been restored in a very satisfactory measure. The hand was still of a dusky color but was warm and was not painful. The ultimate result in this case, insofar as the restoration of function of the patient's arm is concerned, rests largely upon the degree of damage that has been done to the brachial plexus, and how nearly completely the neurological surgeons will be able to repair that damage.

#### SUMMARY

1. The pathogenesis, symptoms and signs of arteriovenous aneurysms have been reviewed.

2. Certain systemic phenomena have been given pointed consideration with especial attention to their cause.

3. The management of arteriovenous aneurysms has been discussed with reference to certain general principles as well as to the definitive treatment. In our experience quadruple ligation and excision has been employed routinely with entirely satisfactory results in all save one case (Case XII). Sympathetic nerve block was used practically routinely in our series and its value as a means of improving and maintaining the circulation in the affected extremity is unquestionable.

4. Some reference has been made to vascular trauma *per se*, that is, independent of arteriovenous fistula. Our experience indicates that when a large artery is ligated, a concomitant ligation of the accompanying vein is a distinct safeguard against subsequent gangrene.

5. Three patients in our series of thirty cases of arterial or arteriovenous trauma lost a limb due to gangrene. There were definite extenuating circumstances in each instance. Their cases are reported.

6. Several additional representative cases are reported, with illustrations of operative procedure.

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# PAINFUL SCAR AND OTHER SURGICAL NEUROSES

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NEUROSIS deserves consideration as a surgical disease. Although it is not ordinarily amenable to operative therapy, no surgeon can be successful unless he is able to cope with it. The word neurosis has been abused by a multiplicity of definitions and has fallen into disuse although the adjective neurotic is heard frequently and with fairly definite meaning. For the purpose of this discussion neurosis can be considered as the willing acceptance of disability. Usually the disability is willingly accepted by the neurotic patient because it is a useful excuse for failure. There is an old saying that the biggest fool is the fool who fools himself. By this standard the neurotic is a fool and essentially dishonest. In self-pity he refuses to accept responsibility for his failure since that would necessitate admitting he was an incompetent weakling who needed to mend his ways. Instead he excuses himself by sickness than which there are few better excuses for failure. The excuse is substituted for the satisfaction of successful accomplishment and is always an easier solution of difficulty. The neurotic offers the excuse to himself so that he may continue to think well of himself. Whatever other instincts and desires may influence his conduct, one of the most important is the necessity of thinking well of himself. If his standards and ideals agree with ours, we admire him, too, and he likes that but our regard is distinctly of secondary importance.

Neurotic patients exhibit varying degrees of awareness of their subterfuge. At one extreme is the malingerer who plans his artificial disability with malice aforethought. Nearby is the compensation neurotic who will not allow himself to contemplate recovery until the case is

settled. It is significant that it is the finality of the settlement and not its favorableness which has the curative effect. In the middle ground is the vast majority of neurotics who have only vague conscious appreciation of their fraud. At the other extreme is the neurotic who more or less honestly fears the effect of activity on his health. A good example of this extreme is the patient with completely quiescent pulmonary tuberculosis. In fact, such "honest" neurotics may not be really neurotic at all, for although they have accepted their disability at their physician's insistence they may have accepted it unwillingly.

The reasons for the neurotic's willing acceptance of disability are infinite. There are as many useful excuses for failure as there are ways of failing. Every child attempts at least once to use sickness as an excuse from school attendance. A weak heart may relieve a wife from bore-some duties. The soldier may seek to escape the hazards of conflict or the rigors of training. No accomplishment in any field of human endeavor is too great or too small to be the object of ambition and to require an excuse for the failure to attain it. Minor failures incite mild neuroses which are exceedingly common and often do not of themselves have much influence on the life of the patient. The poor mental hygiene of such an ineffective attitude in any personal religion or philosophy of life is always of serious import, however.

To himself and to his boss, his friends and relatives it suffices simply for the neurotic to say "I am sick." The situation becomes more complicated when the doctor enters and the neurotic is called upon to explain and justify his disability. Like a thief explaining his loot he sometimes



has difficulty in doing so. The intellectual fumbling and vagueness of the neurotic describing his symptoms are often recognizable as characteristic, especially if the doctor demands details. The symptoms are usually of three types; exaggeration of the distress of normal sensations, exaggeration of mild organic disease, and persistence beyond the natural duration of past organic disease. The essential characteristic is the exaggeration of the severity and the disability. There is always a factual basis of some sort for the symptoms and this must be known before the degree of the exaggeration can be recognized.

The emotional disturbance which may be associated with neurosis frequently interferes with the normal function of the body through the rage-fear mechanism (Cannon).<sup>1</sup> The digestive and circulatory systems are especially susceptible to functional illness although no organ is immune.<sup>2</sup> It is sometimes difficult to distinguish symptoms of functional disorders from neurotic exaggerations of normal sensations. Functional illness may also arise from other types of emotional disturbance quite unrelated to neurosis. Severe functional illness usually arises from more profound mental disturbance than neurosis, such as a psychoneurosis or the irreversible degeneration of a psychosis. A neurosis is commonly successful and therefore not associated with severe mental conflicts.

The following subjective symptoms of functional disorders are often characteristic of neurosis: headache which is dull, generalized and constant rather than sharp, localized and periodic; vertigo which is really a giddiness; deafness when embarrassed; inconstant fatigue diplopia; foul taste in the mouth; globus dysphagia; morning nausea; insomnia not due to pain; morning fatigue; excessive occupational fatigue ("writer's cramp"); fluttering palpitation; sighing dyspnea; precordial pain of long standing not precipitated by exercise; gas distress not relieved by belching or passing flatus;

immediate postprandial abdominal distress; any abdominal pain surviving two abdominal operations; pelvic pain not aggravated by catamenia; dyspareunia; chronic boredom; "jitteriness"; flitting, fleeting aches and pains not rheumatic; symptoms which "get his goat"; symptoms which make the patient nervous; symptoms than which the patient could stand any other kind easier; and finally, any ache or pain or symptoms not ordinarily disabling except for the obvious exaggeration.<sup>3</sup>

More objective evidence of functional disease which may be neurotic in origin are: migraine which suddenly becomes much worse; chronically coated tongue; extrasystoles; paroxysmal tachycardia; fainting; habitual non-productive cough; morning vomiting; low grade fever, never over 100°F.; anorexia nervosa; diarrhea with mucus but without blood; amenorrhea; pruritis ani and vulvae; hyperpnoeic tetany; enuresis; the polyuria and diarrhea of excitement; nail biting; stuttering; spasmodic torticollis; and other nervous habits and ties. Some of these are as characteristic of functional disorder as the whoop is of whooping cough.

The functional illness of nervous indigestion is particularly important to the surgeon contemplating an operation for gallstones or peptic ulcer (Alvarez).<sup>4</sup> A recent cholecystectomy for cholelithiasis failed because the patient continued to complain of a nervous indigestion. Detailed review of the symptoms prior to the operation revealed that the symptoms even then were entirely functional and that the gallstones were in fact silent.

A very common and typical neurosis is the painful scar. Any painful wound healing with a scar creates an ideal situation for the development of neurosis. Many a rugged individualist has discovered the luxury of sympathy and freedom from the demands of ambition during the confinement of an operation or serious injury. The fact of the wound and the visible scar are good presumptive evidence of disability. It is easy to claim

persistence of the severe distress of the healing wound and to exaggerate the normal mild discomfort of the scar. This is especially true, as is too often the case, if the doctor consulted is confused as to the exact limit of possible disability from a healthy scar. Distress in a scar is on the basis of the amputation neuroma phenomenon. Any incision cuts some nerve filaments, the proximal ends of which develop small amputation neuromas. These are hyperesthetic for weeks and in some instances the scar never ceases to be sensitive. We have never seen this sensitiveness disable a healthy minded patient. If a large nerve is cut, a really painful amputation neuroma may develop which requires surgical relief. Such a real amputation neuroma is easily distinguished from a neurotic's exaggeration, however, because it is one of the most sharply localized lesions in pathology. Postoperative hernias and scar contractions are easily recognized, too. Peritoneal adhesions may cause intestinal obstruction but never a painful scar.

Disability following head injury is one of the most difficult situations to evaluate but neurosis is more common than disability from organic changes. Physical injury to the brain without objective evidence and yet severe enough to be disabling must be rare. The episode of the accident and the period of unconsciousness constitute severe psychological trauma following which degeneration of the patient's character is understandable. The complaints are usually those of headache, tinnitus, vertigo, loss of memory, irritability and "nervousness." The organic headache should be sharp, severe, periodic, localized, and disabling but relieved by recumbency like the post-lumbar puncture headache whereas the neurotic's headache is usually constant, dull, generalized and rarely confines the patient indoors. Disabling headache which persists for months after head injury deserves trephine exploration for subdural hematoma anyway. The tinnitus, if disabling, should be

associated with demonstrable and usually unilateral deafness. The vertigo, if disabling, should occasionally cause injurious falls and be associated with nystagmus. The nystagmus may be apparent only after motion such as sudden recumbency or standing upright. Loss of memory is hard to measure but should be associated with impairment of the intellect demonstrable by simple tests such as adding a column of figures or reading a newspaper. The absence of a pre-injury standard for comparison reduces the value of such tests; although if a man who got good marks in school has difficulty in reading and understanding a newspaper, it is easy to believe his memory is impaired. Significant changes in temperament are usually apparent to the patient's relatives.

Too often the neurosis following head injury is unwittingly initiated and encouraged by the doctor in charge of the patient during the convalescence. There is little evidence that prolonged bed rest and inactivity following head injury minimize the organic changes. On the contrary extreme solicitude for a patient who may feel quite active undermines his self-confidence and leads him to expect mysterious unhappy eventualities. Even if convulsions can occur years after head injury it is not wise for the patient to stand around feeling sorry for himself awaiting and expecting them. Head injury cases especially need encouragement and urging to overcome their difficulties. Even in the presence of organic impairment the disability is often neurotic. The detection of this neurosis resolves into a fine point of clinical judgment but is entirely possible and may be done with positive certainty in many instances.

Neurosis often explains the failure of patients to accept surgical relief for hernias and other defects. The refusal is rationalized on the basis of fear of the operation or financial difficulties but in fact the patient is a contented failure with a good alibi. He is often careful to avoid bringing the matter up and may even refuse to

discuss it when he goes to the doctor for some other condition. If the hernia or defect becomes really painful or actually disabling, surgical relief is usually promptly obtained.

Stealing identifies the thief and neurotic exaggerations establish the diagnosis of neurosis. It is emphasized that the diagnosis of neurosis is not simply a matter of excluding organic disease. Rather it is a matter of establishing the full extent of the organic basis so the fact of the exaggeration can be identified and measured. The existence of neurosis must not be allowed to obscure the presence of organic disease. It is very embarrassing to have a hopeless neurotic suddenly die of a disease the symptoms of which had been dismissed as unimportant. Similarly the presence of neurotic features should not preclude the recognition of more serious mental disorders like psychoneurosis and psychosis. It is unnecessary to know the reason for the neurosis or the uses to which it is being put. A social service worker's report on a thief's environment and a psychoanalysis of the neurotic's sub-conscious mind may be interesting and helpful but they are not essential to the diagnosis.<sup>5</sup>

Neurosis is a disease of civilization; where else in nature is disability beneficial? The neurotic is apt to have a family background of emotionally unstable relatives. Many neurotics have been cursed in childhood by indulgent parents who rewarded failure instead of allowing the education of natural consequence to follow unsuccessful efforts. In the army neurosis has been described as contagious from its spread through a group of soldiers like an epidemic. It is practically universal, being no respecter of age, sex, color, or social standing. Doctors commonly learn from their personal experiences with it. Usually the neurotic is constitutionally inadequate and of low intelligence. People in the lower social strata have more failures to excuse and neurosis is more common among them, although they may not as frequently come to the attention of the

doctor. The excessively ambitious who may be actually quite successful in life but whose failures are relative may also resort to neurosis. Certain racial groups seem to be particularly prone to adopt the neurosis mechanism. Neurotics commonly tend to acute exacerbations of chronic deficiencies of the ordinary virtues. They are not particularly happy in their deceit any more than a thief always enjoys his ill-gotten gains, but a successful neurotic is always happier than an unsuccessful one. During economic depressions and after defeat in war whole nations may become neurotic in their refusal to accept responsibility for their misfortunes and blame all their troubles on certain real or fancied social evils.

The therapy of neurosis may be beyond the scope of the surgeon. However, by virtue of his diagnostic investigation, his knowledge of the natural limits of organic disease and his possession of the patient's confidence he may be in a uniquely effective position unattainable by a psychiatrist. Sometimes the surgeon is unable to avoid assumption of responsibility toward neurosis as in the instance of painful scars. It is impossible for the surgeon to be neutral not only because he created the scar but because any evasion or compromise has the effect of fixing the neurosis and dignifying it into the respectability of actual disability. Unless the surgeon actively denies the disability he becomes an accessory to the fraud.

Spontaneous recovery from a neurosis may occur when revisions in the patient's life and environment remove the need for it, just as sudden riches may reform a thief. A temporary remission occurs frequently during severe intercurrent illness the disability of which displaces the disability of the neurosis. Neurotics usually cooperate as good patients immediately postoperatively and put up a good fight against serious illness, but the neurosis commonly recurs when the organic disease subsides. Sometimes the neurotic is caught with his neurosis and although the dis-

ability is no longer needed or welcome, a cure of some sort is necessary to save face. Under these circumstances almost any socially acceptable cure will be effective and the more dramatic the better. Hypnosis, psychoanalysis, a visit to a holy shrine or a famous distant clinic will be satisfactory. Sometimes an ill advised or irrelevant operation will be accepted and be mysteriously successful. A cure from a chiropractor may be very nice, too. By accepting a cure from the chiropractor the neurotic can also give the lie to that mean doctor who told him (1) there was nothing the matter with him, and (2) that the chiropractor was (also) a fraud. Neurotics prefer to patronize the cults who do not embarrass by bothering to make a diagnosis and thus many neuroses never come to the attention of a doctor. Some are discovered accidentally during a consideration of some organic disease or the neurotic may come seeking relief from the excessive discomfort of functional disturbances. Confirmation of the disability and not relief or cure may be the real reason for the visit to the doctor, especially if the neurosis is being successful. Cure of these neuroses is very difficult just as it is difficult to reform a successful thief.

To the extent to which the disability represents an honest fear of the deleterious effect of activity on the patient's health ("honest neurosis") convincing reassurance will produce a cure. These patients have to be thoroughly convinced and it is often difficult to distinguish between the honest fear of disease, the fear of losing the disability and the more serious states of generalized fear associated with psychoneurosis.

Occasionally, confused individuals will respond remarkably to a clarification of their situation by a frank explanation just as a thief may reform after near-discovery or after a good non-specific religious revival sermon. Some neurotics think of their "nervousness" as a symptom of a diseased mind over which they

have no more control than over the fever of pneumonia. When the doctor explains their problem as one of character and not one of health, they may rise to the occasion with will power and courage. The more intelligent and otherwise honorable the patient is, the more probable is a favorable response to a frank discussion. We have compared the neurotic to the thief because we believe the analogy is reasonable and instructive. However, thieves do not bring their vices to the doctor for justification or therapy.

Neurotic patients are often seriously disabled and therefore justify the expenditure of considerable time and effort by the surgeon. Whether successful in therapy or only in antagonizing the patient the conscientious surgeon has the satisfaction of having made an honest attempt and of refusing to be a party to the neurosis. Surgeons tend to avoid the embarrassment of discussing neuroses with their patients although they do not allow the greater embarrassments of operation mortality or morbidity to deny the patient the benefits of their services. Such embarrassment can be avoided in large part by skillfully maintaining an impersonal attitude during the discussion. Any reformer's zeal or display of personal disapproval by the doctor impairs the effectiveness of his efforts anyway. The discussion of the neurosis with the patient should start with a consideration of the factual basis for the symptoms. It is absurd and harmful to dismiss these patients with the simple: "There is nothing the matter with you," or ever to allow the patient to think that his doctor considers the symptoms imaginary. Any effective therapy for any existing organic disease should be insisted upon whether directly relevant to the neurosis disability or not. If the symptoms arise from severe functional illness, a somewhat lengthy education of the patient is required and the assistance of a psychiatrist may be necessary. The concept of functional disease is quite foreign to most patients although fainting and the

polyuria of excitement are useful examples familiar to all. The element of exaggeration of the disability should be discussed on the assumption that it is a manifestation of honest fear of activity. Then should follow definite advice as to the gradual resumption of activity even if it hurts. The disability should be regarded as a handicap to be overcome rather than an insurmountable obstacle; it just must not be allowed to interfere with anything the patient wants to do or ought to do. Reassurance should be very definite that activity will be beneficial and not harmful. The neurotic with a painful scar for instance should be assured that the wound is healthy and that the distress is normal. The scar itself may be firmly massaged by the patient and stretched by body bending exercises if it seems advisable to treat it at all. After every injury there is a last residual soreness of the involved region which has to be worked out by exercise. The symptomatology of disuse has not been thoroughly studied but a perfectly healthy limb kept in a cast is uncomfortable and goes through a distressing readjustment upon return to activity.

So far in the discussion the patient has been given the benefit of every doubt and there has been no embarrassment. If the discussion of the emotional disturbance at the base of the functional illness proves difficult, it may be left for the more skilled management of a psychiatrist. The neurotic reaction of enjoying and benefiting by poor health, etc., can be presented impersonally as an universal human frailty and an element which only the patient himself can say how much it applies to his own present situation. The neurotic will rarely say anything except to deny it even if the discussion is carefully phrased to avoid any accusation. Legal minds regard denial before accusation as evidence of guilt and it usually works out that the more emphatic the denial the more surely correct is the diagnosis of neurosis. If after all discussion the patient insists he

still hurts, there is no better reply than the one "What can't be cured must be endured," but the doctor must be prepared to convince the patient that no specific cure is anywhere available.

The prevalent pessimism regarding the therapy of neuroses arises from the difficulty of influencing neurotics with unskilled efforts, the difficulty of influencing successful neurotics, and the extreme difficulty of influencing any neurotic unless the proper rapport exists between patient and doctor. Effective rapport can only exist when the patient feels his need for advice, i.e., comes voluntarily seeking aid, when the patient has so much confidence in his doctor that he selects him from his competitors, when the patient realizes the doctor is working solely for him and has his welfare alone at heart, and finally when the patient so appreciates the doctor's services that he pays his fee. Advice is usually taken as worth what it costs so it is part of the treatment to insist on the fee being paid.

Absence of rapport is the fundamental defect in any system of socialized medicine. The armed services are currently illustrating the difficulties of socialized medicine in dealing with neurotics. The situation is aggravated by the fact that nearly every soldier is in a position to benefit by disability. Sometimes the most crude efforts at neurotic deception lead to the recognition of the soldier as an undesirable and so he is "rewarded" with a disability discharge and a return home where he can get a lucrative defense job. His instinct of self preservation justifies howsoever otherwise dishonorable efforts to avoid the hazards of combat. If he waits until actual combat before quitting, he is rewarded with a hero's status ("shell-shocked") and often treated with more considerate sympathy than if he had lost a leg. His doctor is handicapped by being accidentally designated and not selected. The medical officer may have been a trusted family physician to a large practice before entering the service but

the neurotic soldier sees him primarily as an officer and, therefore, as a boss, working for the government under the pressure of directives from Washington. That there are not more neurotic quitters under combat is high tribute to the intelligent idealism of our champions of democracy. That the management of neurotic soldiers is as successful as it is, is even higher praise for the doctors of the Medical Corps. Perhaps the medical officers' handicaps are in part compensated by the more bluntly frank methods which have been adopted by most doctors in the Army.

In general it may be said that the medical profession can not point with too much pride at our record in handling neurotic patients. The pessimistic attitude of most doctors toward neurotics is proof of our failure. Doctors express in private their contempt of neurotics and joke rather ruefully at the time and effort wasted on them. Too often, however, the neurotic is actually treated with what amounts to encouraging sympathy by being given placebo prescriptions, "shots," and physiotherapy. The doctor is too kindly (and cautious) to risk offending his patient. One of the most evil aspects of neurosis is its effect upon the patient's family and society. The presence of a neurotic makes any family a sick family and impairs its efficiency in society. The doctor's responsibility extends beyond the patient to the family and society. Nothing less than a bold facing of the problem and a frank discussion discharges this responsibility. Sympathy or any act either of commission or omission which has the effect of en-

couraging and fixing the neurosis is to be lamented. Even if the patient may not appreciate learning the true nature of his condition, a family which understands the situation is better able to defend itself from the impositions of a neurotic member. Excessive concern with the individual at the expense of society is the basis for the accusation that we doctors all belong to the "sob-sister" school of psychiatry.

#### CONCLUSIONS

1. Neurosis is the willing acceptance of disability usually as an excuse for failure.
2. Neurotic patients are more or less conscious of the deception.
3. The exaggeration of disability and certain symptoms are recognizable as characteristically neurotic.
4. The organic basis for the symptom must be known in order to establish the extent of the exaggeration.
5. Surgeons cannot refuse to accept responsibility toward the neurotic patient without in effect encouraging the neurosis.
6. A skillfully conducted discussion of the situation under conditions of good rapport is often surprisingly effective therapy.

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# POTENTIAL ANATOMICAL SPACES IN THE FACE

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**I**NFECTIONS involving the deeper structures of the face present obvious difficulties to the surgeon because the clinical findings usually observed in abscess formations of the superficial structures are not available. Fluctuation following the usual signs and symptoms of infection is still the accepted criterion indicating the optimum time when incision and drainage are to be instituted. However, when deep structures are involved fluctuation is usually not present, although all other clinical findings point to the fact that accumulation of pus has taken place. The interpretation of the clinical findings and the surgical approach of the deep infections of the face depend on accurate knowledge of the anatomy of the face, the fasciae, and potential spaces which may harbor suspected infections.

In recent years the floor of the mouth, cervical fascia and potential spaces have been extensively studied but the deep anatomy of the face apparently remained neglected until Coller and Yglesias reported their findings in 1935.<sup>6</sup> These investigators have included all the potential spaces in the face in a group and called it the masticator space. In addition, they have described the so-called space of the mandible. A review of the literature since the publication of the findings of Coller and Yglesias reveals frequent references and quotations from their article. Grodinsky reported his study of the fasciae and spaces, but failed to mention the space of the body of the mandible.<sup>12</sup> Dorrance<sup>8</sup> and Dingman<sup>7</sup> discussed the presence of the space of the body of the mandible quoting the original publication by Coller and Yglesias. Like Grodinsky, New and Erich<sup>17</sup> reported their results of extensive studies of fasciae and potential spaces stressing the floor of the mouth and

cervical fascia and its compartments. Considering the paucity of available information concerning the deeper structures of the face, this anatomical work was started with the hope that certain important factors might be uncovered which may aid the surgeon in a better understanding of the infections of the face and thus enable him to prognosticate the course of the infection and finally to institute proper and timely treatment.

## METHODS OF STUDY

Dissections with special attention to the possible spaces and fascial distribution were carried out prior to the employment of the injection technic and roentgenographic studies. Because the great majority of infections of the face originate from the oral cavity and associated structures, the sites for injecting materials were determined by the suspected points of origin of an infection. It was soon learned that the spread of the material was similar, regardless of the point of insertion of the syringe. Plaster of Paris was the first material used but was discarded because the ramifications were thin and widespread and made subsequent dissection unsatisfactory. It was found useful in injecting well defined large spaces, especially where a cast of such a space would be desired. Some of the newer plastic impression materials used in dentistry were tried, but these proved to be unsatisfactory because of rapid chilling and their relative radiolucency. The material that was found most satisfactory, easy to manipulate and inexpensive was gelatine with sufficient amount of red lead added to make it radiopaque.

After several trials the following material was used: One tablespoonful of powdered gelatine was dissolved in four ounces

of water over a Bunsen flame. To this was added six teaspoons of red lead and mixed thoroughly. This material allows

sections and roentgenographs are shown. The drawings are those made directly from dissections made by the author and

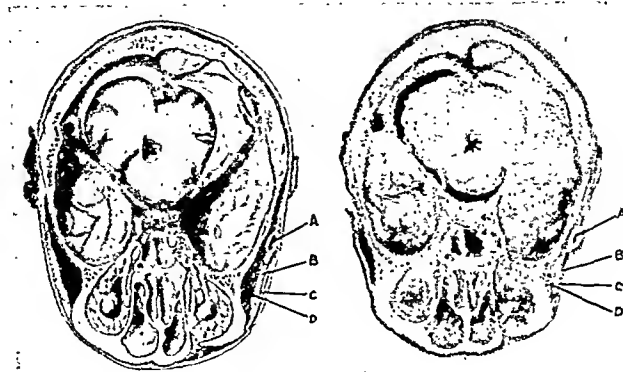


FIG. 1. Horizontal section of a head at a level of the supra-orbital ridge showing the temporal space. A, rubber tube through which the radiopaque material was injected; B, temporal space; C, temporal fascia; D, temporal muscle.

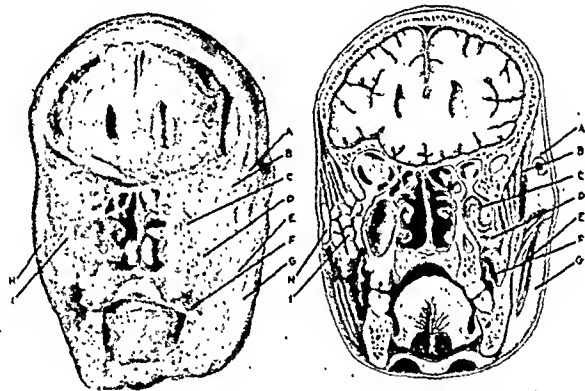


FIG. 2. Frontal section through the region of the ramus of the mandible showing the temporal and infratemporal spaces. A, temporal space; B, temporal muscle; C, internal maxillary artery; D, infratemporal space; E, masseter muscle; F, buccinator muscle; G, subcutaneous space; H, zygomatic arch; I, retrozygomatic fat.

sufficient time for unhurried injection and produces satisfactory contrast against bone on the roentgenographic film. The injected specimens were subsequently roentgenographed, frozen, and then sectioned by means of employing an electrically driven band saw. The saw having four teeth in an inch of its length is the type ordinarily used in the manufacture of wood patterns.

Realizing the temptation of presenting questionable anatomical structures, diagrammatic drawings alone cannot be relied upon. Only actual photographs of

from sections whose photographs are herein presented.

Employing the technic described above, ten adult cadavers were studied. Pertinent anatomical findings are of value to the surgeon only when they serve to clarify inadequately understood regional anatomy and tend to explain the symptomatology of the parts involved. With this in mind the various spaces are described separately. This is followed by a discussion of the fasciae, their distribution and relation to spreading infections of the face.



## TEMPORAL SPACE

This space, constituting the upper portion of the masticator space described by Coller and Yglesias, is bounded laterally by the thick temporal fascia which is firmly attached to the superior temporal line above.<sup>6</sup> Inferiorly it converges and splits into two layers which are attached to the lateral and medial surfaces of the zygomatic arch. The interval between the two layers is occupied by fat in which branches of the temporal and zygomatico-orbital arteries are found. Medially the temporal space is bounded by the temporal fossa which is made up by the squamous portion of the temporal bone, lower part of the parietal bone, a small portion of the frontal bone, and a part of the great wing of the sphenoid bone. This entire area serves as a site of origin of the temporal muscle. The medial and lateral boundaries approach each other posteriorly and superiorly at the temporal line. Anteriorly and inferiorly the position of the zygomatic arch separates the two boundaries markedly. Inferiorly the temporal space communicates widely with the medial portion of the masticator space. Antero-inferiorly it communicates with a space which the author proposes to designate as the retro-zygomatic space.

The temporal muscle occupies practically all of the temporal space. Besides its origin from the bone the muscle presents numerous slips attached to the temporal fascia. The lateral aspect of the muscle itself is covered with a thin layer of fascia which becomes thicker inferiorly and is attached to the sigmoid notch of the ramus of the mandible. In addition to the temporal muscle this space contains a slight amount of fat, loose areolar tissue more pronounced near the angle formed by the zygomatic bone and the zygomatic arch, and the deep temporal vessels and nerves which supply the temporal muscle.

## INFRATEMPORAL SPACE

The infratemporal space is confined in the infratemporal fossa and constitutes

the medial portion of the masticator space. Medially it is bounded by the fusion of the buccinator fascia with the fascia covering the medial aspect of the internal pterygoid muscle. Posteriorly it is separated from the parapharyngeal space by the posterior border of the internal pterygoid muscle and its fascia. Laterally this space is bounded by the ramus of the mandible. The roof of the infratemporal space is formed by the temporal muscle and that part of the temporalis fascia that is attached to the sigmoid notch. Anteriorly and superiorly this space communicates freely with the temporal space beneath the cover of the zygomatic arch. It is also in wide communication with the retro-zygomatic space and with the space superficial to the buccinator fascia occupied by the buccal pad of fat. Inferiorly the medial surface of the internal pterygoid muscle and its fascia limit the space by their attachment to the angle of the mandible.

The infratemporal space contains the external and internal pterygoid muscles, the pterygoid plexus of veins, the first two divisions of the internal maxillary artery and its branches and the inferior alveolar, mylohyoid, buccinator, lingual and chorda tympani nerves.

## BUCCAL SPACE

Surgical consideration requires recognition of a space in the cheek beneath the skin and superficial fascia in the angle formed by the anterior border of the masseter muscle and the zygomatic bone. Medially this space is limited by the buccinator muscle and its fascia. Laterally it is bounded by the risorius, zygomaticus and the quadratus labii superioris muscles, skin and superficial fascia and occasionally by the platysma which may carry with it the deeper layer of the superficial cervical fascia. Posteriorly the anterior border of the masseter muscle and anteriorly the orbicularis oris muscle form its boundaries. Normally this space is occupied by the buccal pad of fat also known as the suc-

torial pad. The space and the fat is pierced almost at right angles by the duct of the parotid gland as it curves over the anterior

the space formed by the zygomatic eminence. The second reason for the presence of the fat in the retrozygomatic space

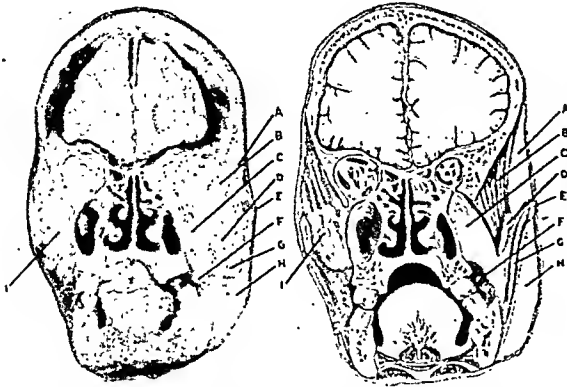


FIG. 3. Frontal section somewhat anterior to the section shown in Figure 2. The temporal, infratemporal and the retrozygomatic spaces are shown. A, temporal space; B, temporal muscle; C, intratemporal space; D, coronoid process of the mandible; E, zygomatic arch; F, buccinator muscle; G, masseter muscle; H, subcutaneous space; I, retrozygomatic space.

border of the masseter muscle. A portion of the fat pad extends posteriorly beneath the masseter and the ramus of the mandible and becomes continuous with the adipose tissue of the infratemporal space. Superiorly a large process of fat extends and fills the retrozygomatic space.

#### RETROZYGOMATIC SPACE

Closed anteriorly by the union of the maxilla and zygomatic bones this horse-shoe shaped space encloses an extension of the buccal fat. The fat surrounds the coronoid process of the mandible and the insertion of the temporalis muscle. Superiorly the space communicates with the temporal space. Posteriorly and medially with the infratemporal and inferiorly with the buccal space. The function of the fat in the cheek is questionable. It is believed to be of importance in the act of suckling and that is the reason for the term of suctorial pad. It is greater in abundance in the negro than in the white race. The presence of fat in the retrozygomatic space, however, appears to have a dual purpose. The first is to fill

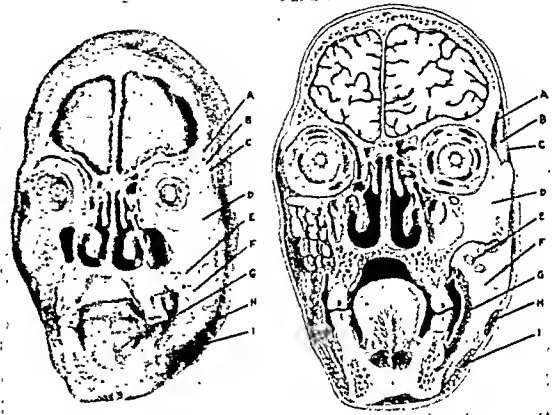


FIG. 4. Frontal section through the zygomatic bone showing the buccal space. A, temporal muscle; B, temporal space; C, temporal fascia; D, zygomatic bone; E, zygomaticus muscle; F, buccal space; G, buccinator muscle; H, risorius muscle; I, triangularis muscle.

can only be speculative in this paper. Its distribution about the coronoid process suggests that it may be instrumental in supplying a restricting force on the anterior and mediolateral movements of the coronoid process. The relatively small displacement observed in fractures of the coronoid process seem to support this theory. The fat contains only small caliber vessels and is lobulated in irregular masses separated by loose connective tissue.

#### FASCIAE

It is generally agreed that fasciae and their distribution play a very important rôle in infections, either by limiting them in confined compartments or by directing the spread of purulent material along planes or sheaths from one area to another. The confusing clinical picture so frequently observed in infections of the face results from the intricate distribution of the deep fascia and its relation to the various compartments described above.

The *superficial fascia* of the face is continuous with the scalp above and the superficial cervical fascia below. Primarily it consists of fibro-areolar tissue which

forms a loose network, the meshes being filled with lobules of fat of various sizes. The fatty layer is firmly adherent to the

Superiorly it is attached to the zygomatic process and is continuous with the temporal fascia above. Anteriorly it dips

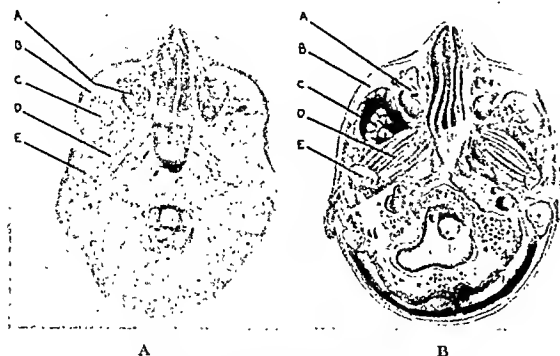


FIG. 5. A AND B. Horizontal section through the level of the zygomatic bone showing the retrozygomatic space. The injected material in Figure 5A is shown in black. A, maxillary zygomatic bone; C, retrozygomatic space; D, external pterygoid muscle; E, neck of the condyle of the mandible.

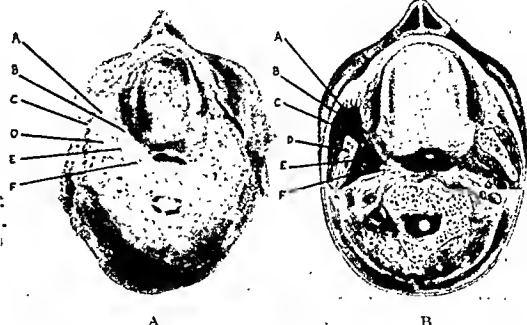


FIG. 6. A AND B. Horizontal section through the middle of the ramus of the mandible showing the free communication existing between the deep and superficial spaces of the face. Figure 6A is reversed. The injected material in Figure 6A is shown in black. A, buccal space; B, buccinator muscle; C, masseter muscle; D, ramus of the mandible; E, internal pterygoid muscle; F, parapharyngeal space.

skin. On the face it presents certain peculiarities. In the eyelids the fat layer is absent and the fascia assumes a loose fibrous character. Beneath the skin of the nose the fatty layer is slight and fibro-areolar connective tissue is the rule. Over the anterior portion of the face the superficial fascia is intimately connected with the muscles of facial expression into which it sends numerous fibrous processes. In the region lateral to the angle of the mouth it becomes more prominent with the buccal pad of fat. The character of this suctorial pad is similar to the fat of the superficial fascia and thus the buccal fat pad is looked upon as a part of the superficial fascia. In other parts of the body the superficial fascia covers the deep fascia. In the face the position of the suctorial fat pad is analogous in that it covers the fascia of the buccinator muscle. Posteriorly the superficial fascia extends and covers the fascia of the masseter muscle and the parotid gland.

The *parotidomasseteric fascia* is an extension of the superficial layer of the deep cervical fasciae. It is attached at the lower border of the angle and posterior one-half of the body of the mandible.

around the anterior border of the masseter muscle, becomes thinner and perforated by a projection of the buccal fat and finally is continuous with the buccopharyngeal fascia. As stated above, this fascia is incomplete as it assumes a medial direction at the anterior border of the masseter muscle. This fact brings out an important clinical significance because an open space in a fascial plane may serve as an avenue for the spread of an infection. Posteriorly the fascia splits to form a capsule for the parotid gland. Above the zygoma this fascia becomes the superficial layer of the *temporal fascia* which covers the temporal muscle. It is tautly drawn between the zygoma and the superior temporal line which serves as its upper attachment. Above that line it is continued as the sub-aponeurotic layer of the *glaea aponeurotica*.

Below the lower border of the mandible the superficial layer of the deep cervical fascia is split. The medial plane extends upward and serves as the *fascia for the internal pterygoid muscle*. At the lower extremity of the internal pterygoid muscle this fascia is in apposition with the fascia

of the superior pharyngeal constrictor muscle. These two planes are easily separated and a potential space is exposed known as the parapharyngeal space. At the anterior border of the internal pterygoid muscle the fascia turns laterally and becomes continuous with the fascia of the masseter muscle. As indicated above, however, there is a considerable defect anteriorly, which receives a portion of the buccal fat. The external pterygoid muscle is covered on its medial aspect by a continuation of the fascia which covers the internal pterygoid muscle. The *buccopharyngeal fascia* covers the lateral surface of the buccinator muscle. It is practically absent near the angle of the mouth but posteriorly it is of considerable thickness. It is attached to the periosteum of the alveolar process of the maxilla in the molar region. Below it fuses with the periosteum of the posterior portion of the mylohyoid line.

At the posterior extremity of the buccinator muscle the buccopharyngeal fascia forms a tough band of tissue extending from the hamular process of the sphenoid to the posterior part of the mylohyoid line. This is the pterygomandibular raphe which serves as a site of attachment for the buccinator muscle anteriorly and the superior pharyngeal constrictor muscle posteriorly. From the pterygomandibular raphe posteriorly the buccopharyngeal fascia covers the superior constrictor muscle and forms the medial wall of the parapharyngeal space.

#### CLINICAL SIGNIFICANCE

Blair pointed out the importance of the buccinator muscle and its fascia in relation to the buccal spread of infections originating from the molar teeth.<sup>5</sup> Apical infections reaching the buccal plate of the maxilla beneath the attachment of the buccinator muscle point into the upper sulcus of the vestibule. These either rupture spontaneously into the mouth or may be drained surgically by incision through the mucous membrane. Similarly

mandibular dento-alveolar abscesses which reach the buccal surface above the attachment of the buccinator muscle likewise

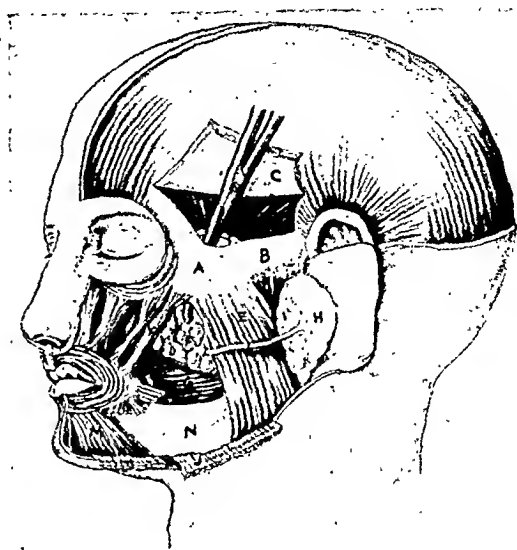


FIG. 7. Drawing made from a dissection showing the communication between the temporal and the buccal spaces. The instrument is shown passing through the retrozygomatic space. A, zygomatic bone; B, zygomatic arch; C, temporal fascia; D, temporal muscle; E, masseter muscle; F, buccal fat pad; G, buccinator muscle; H, parotid gland; I, parotid duct; J, platysma muscle; K, zygomaticus muscle; L, risorius muscle; M, triangularis muscle; N, mandible.

point into the vestibule where they may be evacuated with relative ease. Pus reaching the buccal surface below the attachment of the buccinator muscle in the case of the mandibular molars presents a problem of greater clinical significance. In either case the pus finds its way to the surface of the buccopharyngeal fascia which covers the buccinator muscle. If the first or second molars are the sources of the infection, the pus is usually confined in the buccal space beneath the subtorial pad of fat. It is possible that at any time during the course of an infection resolution may take place with consequent absorption of the purulent material resulting in abortion of the infection. This work deals primarily with the spreading infections which are of grave concern to the surgeon. Furthermore this investigative study is

intended to guide the surgeon in his care of the patient by presenting the pertinent regional anatomy and its influence on the

or osteogenic origin in addition to direct introduction of infection by the needle. Before other clinical symptoms of infection

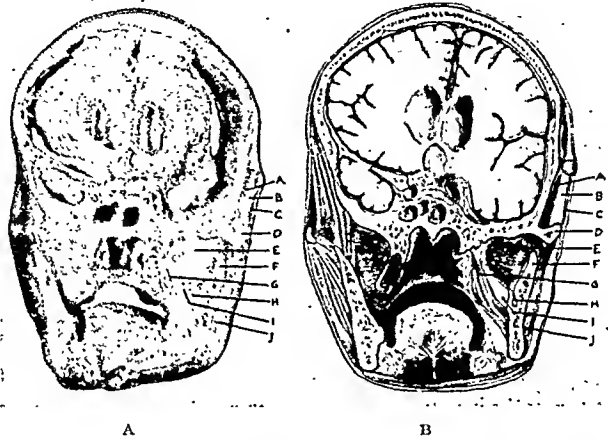


FIG. 8. A AND B. Frontal section of a head through the ramus of the mandible showing the infratemporal space usually invaded by the hypodermic needle in blocking the mandibular nerve. A, temporal muscle; B, temporal space; C, temporal fascia; D, zygomatic process of the temporal bone; E, external pterygoid muscle; F, ramus of the mandible; G, internal pterygoid muscle; H, mandibular foramen; I, infratemporal space; J, masseter muscle.

spread of the infection. Once the buccal space is involved certain clinical findings may be observed. There is swelling of the cheek without observable redness. The mucosa of the mouth and gums appears normal and there is absence of trismus.

From the buccal space the infection may take any of the following routes: (1) It may become subcutaneous and spread over the entire one side of the face and at times into the neck and pectoral region beneath the superficial fascia. (2) Because of the direct communication present the infection may enter the infratemporal space. (3) It may extend directly upward beneath the zygoma and involve the retrozygomatic space, and from there, (4) the temporal space may be involved. (5) Less frequently the infection spreads along the buccopharyngeal fascia and invades the parapharyngeal space.

Figures 8A and B show the area usually invaded by the needle in blocking the mandibular nerve. Infections of this space may be of dental, paradental, paracoronal

are present one outstanding complaint is usually obtained from the patient, that of inability to open the mouth fully. Trismus then is present. Figure 8A shows the position of the internal pterygoid muscle which responds early to any irritation either of trauma or infection. As the infection of the infratemporal space progresses trismus becomes more pronounced and other clinical signs and symptoms become manifest. From the infratemporal space the purulent material gains ready exit anteriorly through the defect in the fascia described above and involves the buccal space. This fact has been observed clinically in spreading infections involving the face. That no barrier exists between the infratemporal and buccal space is brought out by Fouser who described some misadventures with conduction anesthesia resulting from injury of the pterygoid plexus of veins which are found in the infratemporal space.<sup>10</sup> He states: "In case the needle point punctures one of these thin-walled vessels, there is an immediate hemorrhage into the surround-

ing tissues. The blood which has escaped into the loose areolar tissue infiltrates the cheek. The blood then follows the

cient blood supply infections in the retrozygomatic space may persist for a long time and may manifest themselves by

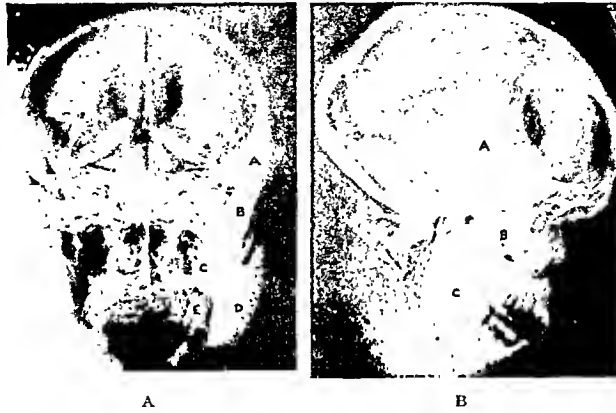


FIG. 9. A, roentgenograph of an injected head showing the distribution of the radiopaque material indicating the location of the spaces of the face; postero-anterior view. A, temporal space; B, retrozygomatic space; C, infratemporal space; D, buccal space; E, parapharyngeal space. B, roentgenograph of an injected head showing the distribution of the radiopaque material indicating the location of the spaces of the face; lateral view. The buccal space is superimposed on the infratemporal and parapharyngeal spaces. A, temporal space; B, retrozygomatic space; C, buccal space.

loose connective tissues along the fascial plane of the muscles of the cheek and may only be limited in its downward course by the attachment of the buccinator muscle to the body of the mandible. The forward course of the blood is limited by the insertion of the muscle fibers of the buccinator muscle into the fibers of the orbicularis oris muscle."

Upward extension of the infection from the infratemporal space may involve either or both the retrozygomatic and temporal spaces. In either case trismus is markedly increased because the temporal muscle becomes involved in addition to the internal pterygoid muscle.

Isolated infection of the retrozygomatic space probably does not exist unless it may become involved secondarily to an osteomyelitis of the zygoma. This space, however, assumes importance because of its position serving as an avenue of communication between the infratemporal and temporal spaces. Because of its recessed position and because it is devoid of suffi-

repeated facial and temporal abscesses. Gillies, Kilmer and Stone recognized the direct communication between the retrozygomatic space when they described the method of external approach in reducing zygomatic fractures.<sup>11</sup> The method consists of inserting an instrument beneath the temporal fascia and passing it down beneath the zygomatic bone and zygomatic arch. Infections likewise may travel unimpeded from the retrozygomatic space into the temporal space. Temporal abscesses present uniform swellings above the zygomatic arch. Because of the toughness of the fascia fluctuation by means of palpation is not readily demonstrated. Spontaneous external rupture of a temporal abscess is infrequent, because of the character and thickness of the fascia. Many investigators make reference to superficial and deep temporal abscesses. In this reclassification of spaces of the face and deep temporal abscesses are those infections which are confined in the infratemporal space. Infections originating in

the temporal space may by downward progress involve the infratemporal and retrozygomatic spaces and from there the buccal and parapharyngeal spaces. At the medial aspects of the angle of the mandible, anterior to the insertion of the internal pterygoid muscle the infratemporal space is approximated by the deep fascia covering the submaxillary gland. The gland may become involved secondarily to infections of the infratemporal space or there may be a direct extension of infections of the third mandibular molar to the submaxillary space. Slightly posteriorly and along the buccopharyngeal fascia the parapharyngeal space is located. Figure 8B shows the possible spread of infection which may involve the floor of the mouth by extension of the purulent material from the infratemporal space anteriorly either above or below the mylohyoid muscle.

Coller and Yglesias described a space which they designated as the space of the body of the mandible.<sup>6</sup> The mandible is covered with periosteum which serves also as a means of attachment of muscles and fasciae. All spaces described are only potential spaces which assume clinical importance when infectious material becomes confined or trapped within them. It should be possible to inject potential spaces in the laboratory if such spaces exist. This work cannot confirm the presence of the so-called space of the body of the mandible.

#### SUMMARY AND CONCLUSIONS

1. Proper management and the interpretation of the clinical findings and the surgical approach of the deep infections of the face depend on accurate knowledge of the anatomy of the face, the fasciae, and the potential spaces which may harbor infections.

2. Because of the close proximity of the region studied to the oral cavity the greater majority of the infections are of dental, paradental and osteogenic origin.

3. The anatomical study of the deep

structures of the face, the fasciae, and potential spaces consisted of dissection, injection of spaces with radiopaque materials followed by frontal and horizontal section.

4. The following spaces or compartments were found by the above method and are here described: (1) temporal, (2) infratemporal, (3) retrozygomatic, and (4) buccal.

5. The infratemporal, retrozygomatic and the buccal spaces as such are described for the first time. The temporal space is included in order to bring out its relation to the spaces mentioned above.

6. The spaces described are not entirely bounded by fascia. Bones, muscles, fasciae and skin make important contributions in the intricate make-up of the spaces in the face.

7. Communications between the various spaces are demonstrated which indicate the possible avenues of the spread of infections.

8. Communication between deep and superficial spaces is demonstrated.

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IT must be understood that *routine wound excision has no place in facial surgery*. That same copious blood supply, which in face wounds is often responsible for profuse and even dangerous haemorrhage, will often ensure the viability of flaps almost completely detached and is responsible for the rarity of serious spreading infection. Gas gangrene is unknown.

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# UROLOGICAL MANIFESTATIONS ASSOCIATED WITH CHRONIC APPENDICEAL ABSCESS

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MEDICAL literature abounds in instances of urological syndromes resulting entirely from lesions outside the genitourinary tract. The majority of these extraneous lesions originate in the intestinal tract. Less frequent, however, have been reports dealing with cases of acute appendicitis giving rise to urinary symptoms. A cursory review of the literature reveals a paucity of material dealing with the subject of chronic appendiceal abscesses in the field of urologic practice. While it is the purpose of this communication to discuss the problem of the chronic appendiceal abscess with regard to its occasional tendency to give rise to urological syndromes, it would not be amiss to review briefly the readily available literature pertaining to the subject of urological manifestations of appendicitis in general.

As far back as 1896 Deaver, in his treatise on appendicitis, mentions this relationship, and attributes the urological symptoms associated with appendicitis to irritation of the sympathetic nervous system.

The problem of hematuria associated with appendicitis has been discussed by a number of observers (Speed, Packard, Becke). Speed reports that in seven patients out of thirteen with acute or sub-acute appendicitis, the urines at the time the patients were admitted to the hospitals revealed from 50 to 200 erythrocytes per high power field. Following appendectomy, the urines were free of red blood cells. This author has tabulated the causes of hematuria as (1) ureteritis; (2) periureteritis; (3) cystitis; (4) pericystitis; (5) septic infarcts to kidneys, ureters, bladder and prostate; (6) toxic hematuria; and (7) light-

ing up of an old urethritis by an acute febrile attack resulting from appendicitis. He believes, however, that the most likely cause of the hematuria is a periureteritis caused by an appendix lying in close proximity to the right ureter.

Packard reported an instance of appendicitis associated with hematuria, apparently originating in the right kidney, but on passing a ureteral catheter into the renal pelvis, urine obtained from the pelvis showed no red blood cells. A somewhat similar case was described by Becke, in which the right kidney was removed because it was believed to be the source of hematuria. Examination of the extirpated kidney disclosed no abnormality, but a subsequent operation revealed the appendix adherent to the stump of the right ureter.

Instances of pyuria associated with appendicitis have also been reported. Harbin believes that pyuria accompanying acute appendicitis is due to pyelitis, which in turn results from a metastatic infection originating in a focus which is also responsible for the appendicitis. In chronic cases he is inclined to believe that the organism, which is usually the *Bacillus coli*, gains access to the kidney by way of the ureteral lymphatics from the affected appendix. Van Duzen reviewed a series of 300 cases of pyelitis and attributed the probable cause to an infected appendix in 7.6 per cent of them.

An interesting case of massive pyuria resulting from rupture of an appendiceal abscess into the bladder was encountered by Keene and cited by Kelly and Hurdon in their treatise, "The Vermiform Appendix and its Diseases" published in 1905. Nielson in a paper published in 1932 deal-

ing with this subject was able to collect twenty cases of this type from the available literature.

Reports dealing with vesico-appendiceal fistulas are meager. In Kelly and Hurdon's book a case of Kindgon is cited in which a patient passed worms through the urethra, and urine in the stool. Postmortem examination disclosed an appendix which was adherent to and communicated with the bladder.

A case of reflex anuria associated with appendicitis was reported by Abdanski in 1929. Cope maintains that appendicitis in males is associated with testicular pain in 5 per cent of cases, and attributes this to irritation of the sympathetic nerves situated in the wall of the right spermatic artery. He also attributes the phenomenon of right costovertebral tenderness frequently associated with inflamed appendices lying in retrocolic position to irritation of the tenth dorsal spinal nerve which is supposed to innervate the appendix. Retraction of the right testicle has been occasionally noted associated with acute appendicitis and is believed to be due to contraction of the cremaster muscle from irritation of the right genitocrural nerve.

An unusual case of priapism associated with appendicitis was described by Long in the course of a discussion of a paper written by Harbin. In this case the appendix was gangrenous and was found lying in close proximity to the right ureter.

An interesting case was recently described by Ehlert, of a boy fifteen years of age, who was admitted to the urologic service complaining of dysuria, inability to void, chills, fever, nausea and vomiting. The urine was cloudy due to pus cells, and on physical examination a mass was felt above the symphysis pubis. The diagnosis was acute cystitis with urinary retention. Postmortem revealed a generalized peritonitis due to a ruptured gangrenous appendix which was situated directly in the midline, on top and slightly in front of the bladder, and adherent to the bladder.

## CASE REPORTS

The three cases about to be presented are unique in that few if any similar cases have been previously reported.

CASE 1.\* Mr. R. D., aged fifty-five, was seen by us December 18, 1941, complaining of dysuria, diurnal and nocturnal urinary frequency and pain in the urethral meatus. The past history was uninformative.

For the past six months he had been complaining of a sense of fullness in the perineum, with dysuria and increased diurnal and nocturnal frequency, voiding eight times during the day and three times at night. Lately he experienced pains in the meatus and suprapubic discomfort. During the past few weeks he had had bouts of diarrhea and rectal tenesmus. There was a loss of ten pounds in weight during the past six months.

A No. 21 Brown Buerger cystoscope was introduced into the bladder with considerable difficulty due to marked spasm in the region of the sphincter. Bladder capacity was reduced and there was a well defined median bar and collar contracture of the vesical neck. The base of the trigone was narrowed.

Rectal examination disclosed a stony-hard "shelf" situated above the upper border of the prostate gland, involving the anterior wall of the rectum, and extending half-way around the circumference of the rectum. The mucous membrane covering the "shelf," however, appeared to be intact. The prostate was small and of normal elasticity.

Physical examination revealed a well developed male who did not appear acutely ill. Save for the rectal findings above described, the physical examination was essentially negative.

Roentgenological examination of the urogenital tract revealed nothing abnormal.

Barium enema roentgen study disclosed a suspicious ragged deformity in the region of the rectosigmoid.

Sigmoidoscopy revealed the following: Situated about three inches from the external anal sphincter there was a nodular shelf involving the anterior rectal wall. Three specimens were taken for biopsy from different parts of the lesion. These were reported "inflamed fibroadenomatous rectal polyp showing prominent

\*J. A. L. reported in *J. Urol.*, vol. 50, no. 1, July, 1943.

mitoses. There is no epithelial cell invasion of the stroma. The glands appear regular."

Although it was believed that we were deal-

flexure lying to the left, the terminal portion of the ileum to the right, the posterior wall of the bladder ventrally, and the promontory of

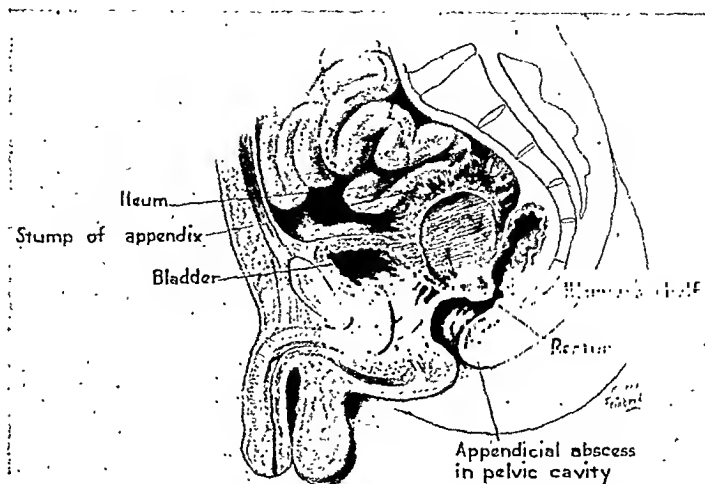


FIG. 1. Diagrammatic sagittal view showing relationship between abscess cavity, bladder, stump of appendix and rectum. (Note formation of Blumer's shelf.)

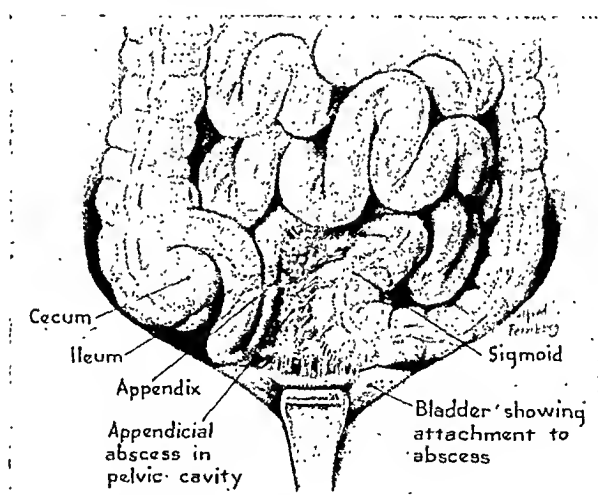


FIG. 2. Diagrammatic view showing relationship between abscess cavity and bladder, sigmoid, terminal ileum and appendiceal stump.

ing with a typical "Blumer's shelf," absence of distinct evidence of malignancy in the biopsy specimens warranted an exploratory laparotomy.

Operation was performed on January 9, 1942. (Figs. 1 and 2.) Under spinal anesthesia the abdomen was opened through a four-inch left paramedian suprapubic incision. A mass the size of a large orange was found situated deeply in the pelvis behind the bladder. This mass comprised the mesial wall of the sigmoid

the sacrum situated posteriorly. Planted directly into the center of the mass was the proximal half of the vermiform appendix, the terminal portion of which had completely sloughed off. The sigmoid flexure and ileum were densely adherent to the mass. A collection of thick, inspissated, putty-like material was found in the center of the area of tumefaction. The proximal half of the appendix and its mesentery were thickened but the caput coli was in no way involved.

With the patient in high Trendelenburg position, the abdominal contents were displaced caudally and held in place with warm

median bar and contracture of the vesical neck. Careful interrogation failed to elicit a history even remotely suggestive of

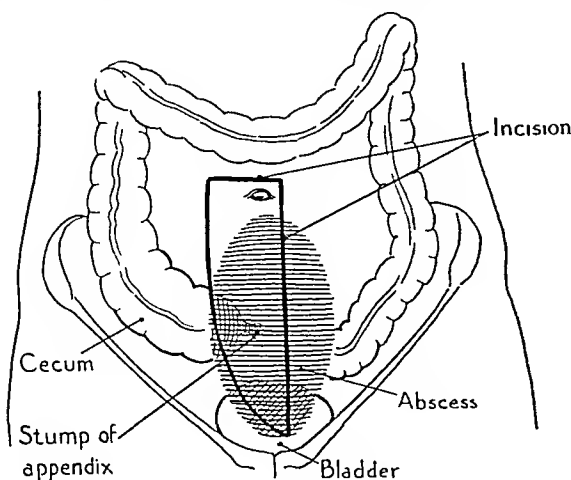


FIG. 3. Schematic drawing, anteroposterior view, illustrating the relative position of the abscess cavity to the anterior abdominal wall, cecum and bladder, and the line of incision.

packs, thereby clearly exposing the pelvic lesion. The sigmoid and terminal ileum were carefully separated and freed from the bladder by blunt gauze dissection. The proximal half of the appendix was freed and removed in the usual manner and its stump carbolyzed but not inverted. The thick inspissated pus was evacuated by suction and 10 Gm. of sulfanilamide crystals was evenly distributed within the abscess cavity. A rubber dam drain was placed deeply into the pelvis behind the bladder, and two small rubber tubes were introduced in the immediate vicinity of the appendiceal stump. The wound was closed in layers around the drains.

Recovery was completely uneventful. The rubber dam was removed on the sixth post-operative day and the sutures on the seventh. All drains were out on the eleventh day, and he was discharged from the hospital on January 22nd, thirteen days after operation. When last seen he was symptom-free, and the rectal shelf had completely disappeared.

**Comment.** This case presents a number of interesting and unusual features. Here we have a patient who presented himself with symptoms of prostatism and who, following a cystourethroscopic examination, was found to have a well defined

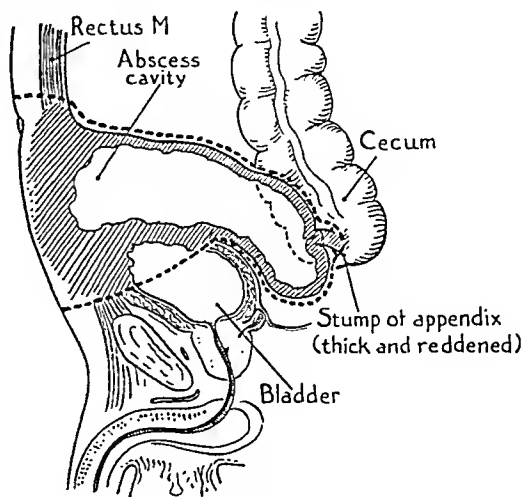


FIG. 4. Schematic drawing, sagittal view, showing the position of the abscess cavity to the anterior abdominal wall, cecum and bladder. The dotted line shows the extent of removal of the anterior abdominal wall in the operative procedure.

appendicitis. Upon rectal examination, however, a rectal "shelf" was found which usually signifies the presence of a metastatic lesion in the cul-de-sac and therefore an inoperable condition. Yet, surgical intervention disclosed the underlying cause of this patient's difficulty to have been an old appendiceal abscess which, because of its location, gave rise to symptoms of prostatism and also to the development of a pelvic ridge which was highly suggestive of a "Blumer's shelf." Following appendectomy and drainage of the abscess cavity, all symptoms disappeared, including the "rectal shelf."

**CASE II.\*** N. L., aged fifty-two, seen September 19, 1942, complained of increased urinary frequency, nocturia, backache and loss of weight (twenty pounds). He was observed at one of the metropolitan hospitals where a diagnosis of carcinoma of the prostate was made. Before submitting to surgical interference, he insisted upon another opinion.

Cystoscopy revealed a well defined median bar with slight congestion of the verumont-

\*J. A. L. reported in *J. Urol.*, vol. 50, no. 4, October, 1943.

tanum. There was no evidence of lateral lobe enlargement. By rectum the prostate felt normal in size and consistency. Situated above the upper margin of the prostate there was a rigid, bar-like structure.

Barium enema disclosed no evidence of disease in the colon.

Physical examination showed an acutely ill male, who presented no findings other than those mentioned above. Temperature was 102°F.; blood count: hemoglobin 10.6 Gm. per 100 cc. of blood; erythrocytes 3,900,000 per cu. mm.; leukocytes 20,300. Polymorphonuclears 67 per cent. Urinalysis was essentially negative.

Preoperative diagnosis: Pelvic abscess in juxtaposition to bladder (appendiceal abscess).

Operation was performed on September 24, 1942. Under spinal anesthesia the abdomen was opened through a four-inch right paramedian incision. The serosa of the small intestine was injected. There was a small amount of serosanguineous fluid in the peritoneal cavity. Situated deeply in the pelvis there was a large mass, the left boundary of which consists of the mesial surface of the sigmoid flexure. A loop of indurated, injected terminal ileum was adherent to its upper surface. The posterior wall of the bladder formed its anterior boundary, while the caput coli, which appeared to be uninvolved, was situated to the right and directly above it. The appendix was not immediately visualized. After separating the loop of ileum from the mass, an abscess cavity was encountered and much pus evacuated. Careful blunt dissection of the ileocecal region showed the stump of the appendix to measure approximately 1.5 inches. The distal portion of the appendix was found completely sloughed off.

The appendiceal stump was extirpated and the cavity drained. Eight Gm. of sulfanilamide were salted into the pelvis. The patient was discharged from the hospital symptom-free on October 8, 1942.

CASE III. Mr. C. K., aged fifty-nine, was seen November 5, 1943, complaining of a suprapubic swelling, dysuria, increased diurnal and nocturnal urinary frequency and loss of weight extending over a period of a few months. About two and one-half years previously he experienced an attack of pain in the right lower quadrant accompanied by vomiting. During and after this episode, he was examined

in the out-patient department of a large metropolitan hospital and dilute hydrochloric acid was prescribed. Although the acute pain subsided in ten days, during the next two years he suffered from bouts of diarrhea alternating with constipation. About two or three months ago a swelling appeared in the lower abdomen, and he began to complain of urinary symptoms as previously mentioned.

Physical examination showed an emaciated male about sixty years of age, who looked chronically ill, and disclosed a hard, ovoid, non-tender mass in the midsuprapubic region, extending from the symphysis pubis to the umbilicus. Large lymph nodes were palpable in both groins. Blood pressure was 115/80. Rectal examination was negative; the prostate was slightly enlarged and firmly elastic.

A No. 21 Brown-Buerger cystoscope was easily introduced into the bladder. There was 6 ounces of amber, clear, residual urine. Situated on the upper posterior wall of the bladder there was a nodular intrusion about the size of an English walnut. The mucosa covering this nodular area of bladder wall was smooth and not ulcerated. There was a collar contracture of the vesical neck, with slight hypertrophy of the lateral lobes of the prostate.

Urinalysis revealed the following: Specific gravity 1.004; albumin and sugar negative; microscopic 1-2 leukocytes and an occasional erythrocyte per high power field. Bacteriology of bladder urine: Negative on smear and sterile on culture; Tbc negative.

Blood Wassermann negative.

Preoperative diagnosis: (1) Intra-abdominal carcinoma involving the bladder; (2) sarcoma of the abdominal wall involving the bladder.

Operation was performed on November 6, 1943, by one of us (J. A. L.): Under spinal anesthesia (tropococaine) a midline incision was made commencing at the symphysis pubis and extending upward above the umbilicus to the left of the midline for a distance of three inches. An attempt to enter the peritoneal cavity directly above the symphysis was unsuccessful because of the sclerotic character of the tissues beneath the skin. It was only after the incision had been lengthened above and to the left of the umbilicus that the peritoneal cavity could be entered.

Situated in the midportion of the abdomen and extending from the symphysis pubis to

the umbilicus there was a mass of stony-hard consistency. The lower portions of both recti muscles directly over the area of tumefaction felt sclerotic. The mass was firmly adherent to the vault of the bladder. The cecum was adherent to its posterior surface, and after careful dissection the appendiceal stump, thickened, reddened and with indurated mesentery, anchored the caput coli to the center of the area of tumefaction. It was now evident that we were dealing with an old chronic indurated abscess resulting from a gangrenous appendix which had ruptured into the anterior abdominal wall. The wall of the abscess was markedly sclerotic, and about three ounces of thick, inspissated pus was found within the center of the mass. A portion of the bladder vault was intimately adherent to the abscess wall. (Figs. 3 and 4.)

After entering the peritoneal cavity the intestines were carefully packed off into the upper abdomen and the borders of the mass clearly defined. The base of the appendix was crushed, and divided with a carbolized knife between two ligatures, and the cecum replaced into the upper abdomen. The abscess cavity was opened and about three ounces of pus evacuated. In order to extirpate the area of tumefaction completely, it was necessary to remove a portion of the bladder vault to which it was intimately adherent. The bladder wall was closed around a tube with two layers of fine chromic catgut. Ten Gm. of sulfanilamide crystals were evenly distributed through the pelvis and around the bladder. The reconstructed bladder was extraperitonealized by approximating the peritoncum covering the psoas muscles on either side of the bladder and to the serosal layer of the rectosigmoid. The abdominal wall was closed with a series of heavy silk sutures, incorporating all layers of the abdominal wall except the skin which was closed separately with interrupted silk sutures. Drainage consisted of one packing and one rubber tube to the space of Retzius and one packing and one tube to the space above the bladder.

*Comment.* This is a case of an old chronic appendiceal abscess in a male patient who showed a large midline suprapubic tumor, and who complained of dysuria, increased diurnal and nocturnal

urinary frequency and loss of weight. About two and one-half years previously he experienced an attack of what now appears to have been acute appendicitis, but which had not been recognized as such at that time. For two years thereafter he had bouts of diarrhea and constipation. During the past two months he noted a swelling in the lower abdomen and began to complain of urinary symptoms. Operation disclosed an old appendiceal abscess involving the anterior abdominal wall and a portion of the vault of the bladder.

#### SUMMARY AND CONCLUSIONS

Acute appendicitis can give rise to urological symptoms. A brief review of the literature pertaining to this subject is presented in an attempt to emphasize the motivating causes of these urological manifestations. Three unusual cases of chronic appendiceal abscess with unusual urological features are presented.

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# INTRASTERNAL INFUSIONS IN OBSTETRICAL HEMORRHAGE\*

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THE conquest of hemorrhage has played a major part in the reduction of maternal mortality in the last decade. The intravenous infusion of blood and plasma has become so easy and safe, this procedure is now relegated to the junior intern or, in many clinics, to the nursing staff. But the veins may fail us when we need them most, as in patients with very severe hemorrhage when the peripheral venous system is found to be collapsed.

In this desperate situation or when for any other reason the intravenous route is not available, we have found the recently developed method of intrasternal infusion of tremendous value in obstetrical hemorrhage.

In the treatment of pernicious anemia Josefson,<sup>1</sup> in 1934, injected a liver preparation intrasternally. In 1940, Tocantins<sup>2</sup> bled rabbits and reinfused the blood into the bone marrow of the tibia. He noted that the hemoglobin and red blood cell counts returned to normal in twenty-four hours. He then demonstrated that mercury injected into the human sternum soon issued from the severed internal mammary veins on the undersurface of the sternum. Next Tocantins infused saline solution into the sternum of three men successfully. He stated that the intrasternal route may offer one more means of administering parenteral therapy when speed was desirable and the usual pathways unsuitable.

In 1940, Tocantins and O'Neill<sup>3</sup> administered citrated blood, plasma, and glucose-saline solutions to adult patients via the sternum and used, with equal success, the

tibia and femur of children. No local or constitutional reactions were observed clinically or by x-ray.

Henning,<sup>4</sup> in 1940, proved that substances injected into the medullary cavity rapidly find their way into the circulation. He pointed out that in military surgery this would have many advantages. The sternum is always readily accessible and the needle is firmly fixed in the compact layer of bone and is not easily dislodged in restless patients or those who must be transported considerable distances.

Meyer and Perlmutter<sup>5</sup> demonstrated that the circulation times tested with saccharin, arm to tongue and sternum to tongue, were essentially the same.

Subsequent articles by Tocantins and O'Neill et al.<sup>6-10</sup> have demonstrated the value and safety of this method. Papper and Rovenstine<sup>11</sup> and others have also shown the value of osteoclysis. The latter two workers reported easy and rapid anesthesia with sodium pentothal administered through the sternum.

## TECHNIC

The skin over the sternum is prepared with alcohol and iodine. A 1 per cent solution of procaine is infiltrated into the skin, subcutaneous tissue, and the periosteum in the midline over the manubrium or over the body of the sternum below the angle of Louis.

An ordinary B-D 15 gauge needle  $1\frac{5}{16}$  inch long with a stylet is then inserted vertically with bevel up through the periosteum. With the needle then tilted at a thirty degree angle to the skin moderate firm constant pressure is used until a

\* From the Obstetrical and Gynecological Service of the Carney Hospital. Presented at the annual meeting of the New England Obstetric and Gynecologic Society, Boston, December 6, 1944.

sensation of "give" occurs; this indicates piercing of the anterior plate of the sternum. The end of the needle now lodges in the marrow cavity. The needle is held firmly in place by the bony plate. A 2 cc. syringe with 1 cc. saline is connected to the needle and 0.1 to 0.2 cc. blood-marrow mixture are aspirated. Next 2 cc. saline are injected slowly into the sternum. To prevent marrow clotting in the needle the adapter of the tubing connected to the usual gravity infusion apparatus is then quickly attached to the needle in the sternum. The rate of flow is adjusted according to the needs of the patient. The needle and surrounding area are covered with sterile gauze.

Only in the event of deep shock is it deemed advisable to inject blood or plasma rapidly with a large syringe directly into the sternum. The rate of flow may diminish after some hours or the flow stop, but this is remedied by reinserting and removing the stylet and injecting 2 cc. of saline under slight pressure. This may cause slight discomfort to the patient locally. In this same manner, when the patient has received adequate fluids, the gravity infusion apparatus is disconnected, the stylet inserted into the needle and sterile dressings placed over this. The next day the stylet may be removed, 0.5 cc. saline injected, 0.1 cc. blood-marrow mixture aspirated, 2 cc. saline injected and the administration of blood and other fluids started again. The needle has thus been allowed to remain for six days.<sup>11</sup> Doud and Tysell<sup>12</sup> in a case of uncontrollable bowel hemorrhage in ulcerative colitis permitted the needle to remain in place five days and one day later reinserted it for four days without after-effects. Fluids may be permitted to run through two needles at the same time, one in the manubrium and one in the gladiolus.

#### PRECAUTIONS

1. Strict asepsis should be maintained from the time the skin is prepared for procaine infiltration until after removal of

the needle, when the site is again prepared with alcohol and iodine and a sterile dressing applied.

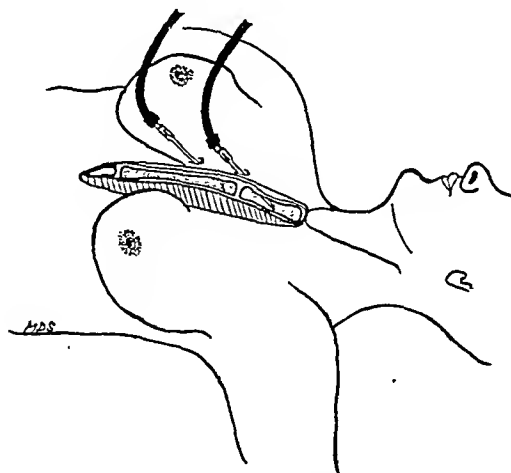


FIG. 1. Sketch showing one needle in sternal body and one needle in manubrium.

2. Osteoclysis is contraindicated in cases with septicemia.

3. One should guard against piercing the posterior sternal plate. The sternum in infants and children is poorly developed and should not be used.

4. If marrow cannot be aspirated, fluid must not be injected. The lower femur or tibia has been used satisfactorily and may then be used. In children only the latter sites should be selected.

5. Not more than one puncture should be made in the manubrium unless twelve hours have elapsed. An unsuccessful puncture in the body of the sternum at one place may be repeated only at some distance from the first. Some of the fluid running through the second puncture may flow out of the first puncture if the pressure be great enough and the openings close together.

6. Circulatory overloading is to be avoided as with intravenous administrations.

7. Hypertonic and irritating solutions should not be used.

#### INDICATIONS

The intrasternal route may be used when there is profound shock with collapse of



the peripheral veins, when rapid massive administrations of blood, plasma, and other fluids are desirable and when the time-consuming dissection of veins might be disastrous. Frequently when such veins are isolated they are found to be collapsed or are too small for the rapid infusion of fluids. Other conditions in which the intrasternal route is recommended are widespread burns, mutilations, (as when the extremities have been amputated), thrombosed veins from repeated intravenous injections, patients requiring long-continued parenteral fluid therapy and in very restless patients. In infants and children, as stated above, the femur or tibia should be used.

#### CASE REPORTS

The following cases are reported to demonstrate the value of intrasternal infusion in obstetrics:

CASE 1. No. 441617. Mrs. S., a thirty-eight-year-old quadripara, was admitted to the Carney Hospital, April 3, 1944. One hour before admission she was awakened during the night by vaginal bleeding.

The last menstrual period occurred six and one-half months previously and her pregnancy had progressed normally up to the present time. She had three previous transverse cervical cesareans. The first was performed for cephalopelvic disproportion after a sixteen-hour trial labor. The other two were performed electively. There had been no serious illnesses and no other operations.

On physical examination the patient was well nourished but with noticeable pallor of the face and mucous membranes. The temperature was 99°F., pulse 88, and respirations 22. The heart rate was regular. The blood pressure was 110 systolic, 60 diastolic. There was slight cardiac enlargement, a systolic thrill, and a blowing apical systolic murmur. The fundus was three fingers above the umbilicus. The uterus was flaccid and nontender, and the fetal heart rate was 136. The hemoglobin was 55 per cent with 2.58 million red blood cells, 7,100 white blood cells. The blood Hinton was negative. The patient was RH positive, and the urine was normal except for a few pus cells.

The flowing subsided soon after admission and the following day the patient received 500 cc. citrated blood. For the next four days there was occasional staining. For three days there was no further showing of blood and the patient was permitted to get out of bed. The following day a sudden profuse hemorrhage occurred. An intravenous whole blood transfusion was started and the patient was taken to the operating room. Under spinal anesthesia a transverse cervical cesarean section was performed with the delivery of a living female infant weighing 2 pounds, 10 ounces;  $\frac{1}{320}$  gr. of ergonovine malleate was given intravenously. A central placenta previa was found and after removal of the placenta there was free bleeding from the placental site which was controlled by pressure. The fundus contracted well. The operation was speedily completed but when the skin was being sutured the patient began to bleed profusely from the vagina. The blood pressure dropped until it could not be obtained and the patient became pulseless. She was placed in deep Trendelenburg position, the cervix was exposed with a speculum, and the uterine cavity and vagina were firmly packed with a gauze strip impregnated with sulfanilamide. It was noted that the blood transfusion had stopped running. Veins were exposed by incision but were found to be collapsed. The patient appeared to be in extremis. After preparation of the skin over the sternum with alcohol and iodine but without local anesthesia, a No. 15 needle was inserted into the body of the sternum and blood and plasma administered rapidly by this route. Twenty minutes later the radial pulse was felt feebly at 130 per minute and the blood pressure was found to be 40/0. The patient was kept for the ensuing three hours on the operating table where she received intrasternally a total of 1,500 cc. whole blood, 1,000 cc. plasma, and 500 cc. physiologic saline. The blood pressure gradually rose to 95/60 at the end of the three hours and the pulse was of fair quality, rate 120, and the patient was returned to the ward where an additional 1,000 cc. of whole blood were given. It was later possible to enter a small vein in the right arm and when the intravenous solution was running well six hours after the operation and the blood pressure and pulse were satisfactory the needle in the sternum was removed, alcohol and iodine were applied to the site of

sternal puncture and a dry sterile dressing applied. During the next twenty-four hours 3,000 cc. of 5 per cent glucose and saline

at 11:30 A.M. she complained of pain in the lower abdomen and back particularly at the left lower quadrant. At 7 P.M. of the same day

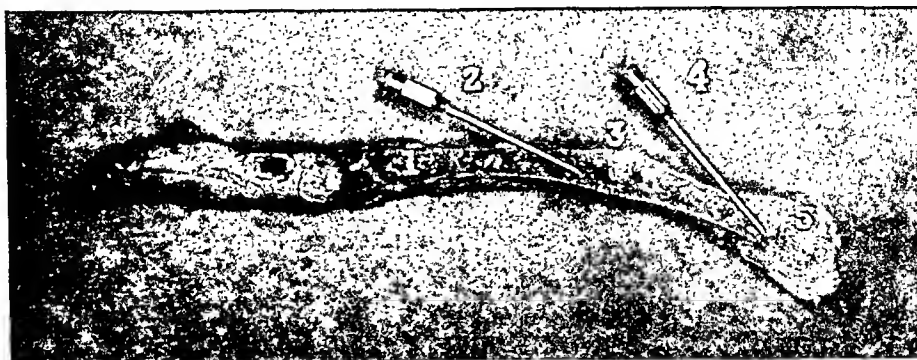


FIG. 2. Longitudinal section through the human sternum. 1, body of sternum; 2, needle in body of sternum; 3, angle of Louis; 4, needle in manubrium; 5, manubrium.

were given intravenously together with 5 Gm. of sodium sulfadiazene and 80 cc. of 1 molar sodium lactate.

For the next six days the patient received 1 Gm. of sulfadiazene every four hours with an equal amount of sodium bicarbonate by mouth. Eighteen hours after operation and after getting 2,500 cc. whole blood the red blood count was 1.5 million with a 35 per cent hemoglobin. This revealed the degree of blood loss that had occurred; 2,000 cc. whole blood were given during the second and third postoperative days. The temperature rose to 101°F. on the second postoperative day and thereafter remained below 99°F.

There was slight vaginal oozing of blood for one and a half days. The uterovaginal pack was removed on the second day.

The patient was discharged on the nineteenth postoperative day in excellent condition with a hemoglobin of 75 per cent and a red blood count of 3.4 million.

CASE II. No. 442609. Mrs. R., a thirty-one year old female, was admitted to the Carney Hospital at 12 noon on June 4, 1944, complaining of lower abdominal pain and slight vaginal bleeding during the previous forty-eight hours. She had a normal full term pregnancy in 1933 and a miscarriage at two months in 1937. She had always been in good health and had had no operations. Her last regular menstrual period occurred on April 5th and was normal in all respects. On May 2nd and for the ensuing two weeks she had slight vaginal bleeding with the passage of a few small clots but there was no associated pain. On June 2nd

she began to have some slight vaginal staining. About twenty-four hours later on June 3rd, she experienced pain in the right shoulder followed in a few minutes by pain in the left shoulder.

Physical examination revealed a well developed and somewhat obese young female complaining of lower abdominal pain. The blood pressure on admission, was 130/90, pulse 110 of fair quality, temperature 98.4°F. Her abdomen was moderately distended and generally tender with flatness to percussion in the flanks, the greatest tenderness being at the left lower quadrant. Rectal examination revealed a thick closed cervix. Extreme tenderness was elicited on palpation of the cervix. There was fullness in the cul-de-sac of Douglas and in both lateral vaults. The hemoglobin was 50 per cent, Sahli, red blood count 2,460,000, white blood count 30,300. A diagnosis of ruptured left tubal pregnancy with hemo-peritoneum and early shock was made and preparations for operation started. While the patient was being typed and cross matched, 250 cc. of plasma were administered intravenously and this was followed by a continuous drip of 5 per cent glucose in saline. Arrangements were made for the sterile aspiration and collection of free blood from the abdominal cavity. A blood transfusion was started intravenously as the operation was begun. The blood pressure at this time was 90 systolic and 60 diastolic.

A laparotomy was performed. On opening the abdomen the peritoneal cavity was found filled with free and clotted blood; 550 cc. of

the free blood were aspirated into a sterile flask containing 100 cc. of sodium citrate solution. The clotted blood was removed. As the free blood was being aspirated, quick exploration of the pelvis revealed a rupture to be at the isthmus of the left tube and there was active bleeding. Left salpingo-oophorectomy was quickly performed and the bleeding controlled. At this time her blood pressure dropped to 80 systolic and 20 diastolic. The pulse was thready and weak with a rate of 130. The transfusion ceased running abruptly, the needle having been dislodged from the only available good vein. Attempts to find another suitable vein failed, therefore, an intrasternal transfusion was started below the angle of Louis and the blood allowed to run in rapidly. Fifteen minutes after the osteoclysis was started the blood pressure had risen to 95 systolic and 50 diastolic and the pulse had dropped to 100.

The patient was returned to her room and although she was extremely restless when coming out of the ether anesthesia, the needle remained firmly fixed in the sternum and the blood infused at the rate of sixty drops a minute. After the first 500 cc. of blood were allowed to run in, the 650 cc. of the patient's citrated blood which were obtained from the peritoneal cavity were inserted. This was followed by 1,500 cc. of 5 per cent glucose in saline and at 8 A.M. the following morning, the patient being in good condition, the intrasternal needle was removed. The hemoglobin at this time was found to be 45 per cent, Sahli, and the red blood count 2,150,000. Her post-operative course was entirely uneventful.

The microscopic report revealed a ruptured ectopic tubal pregnancy with chorionic villae,

decidua and trophoblastic giant cells. She was discharged on the thirteenth day at which time her hemoglobin was 70 per cent, Sahli, with a red blood count of 3,680,000.

#### SUMMARY AND CONCLUSIONS

Intrasternal infusion is a life-saving procedure in severe obstetrical hemorrhage when the peripheral veins have collapsed. In less urgent cases it may be used routinely when the ordinary intravenous routes cannot, for any reason, be utilized.

The technic, indications, and necessary precautions are described.

Two cases, illustrating the value of the method, are presented.

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# SIMPLIFIED PROCEDURE FOR THE TREATMENT OF IMPASSABLE URETHRAL STRICTURES AND RUPTURE OF THE URETHRA

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**I**MPASSABLE urethral stricture and rupture of the urethra, two separate entities, are considered together because they are alike in that with both there is (1) dissolution of continuity of the urethra, (2) there is retention of urine, and (3) the bulbomembranous urethra is usually the site of involvement. Because of these similarities the same general plan of treatment applies to both.

It is of practical importance to outline the management of these very serious conditions at the present time for several reasons. First, the student is taught little of practical value about their management in medical school; secondly, reference to text books and medical literature on the subject reveals a surprising lack of unanimity of opinion as to treatment. Writers are unanimous in stressing the gravity of these conditions, and rightly so, but they err in overemphasizing the difficulties and complexities of treatment in involved discussions which cannot help but leave the student in a state of utter bewilderment. The fact that so many different operative procedures are proposed for these conditions shows that the men who are doing them are not entirely satisfied with what they are doing. This is analogous to the medical treatment of disease in which the efficacy of treatment is in inverse ratio to the number of remedies proposed. As a matter of fact, their management is comparatively simple if a few simple principles of treatment are understood and followed. It is not outside the scope of the general practitioner to handle these problems successfully, and it is particularly important at the present time that he assume a useful rôle in their management because of the

increasing number of urethral injuries resulting from the accelerated pace of industry and as a result of war wounds.

Let us start first with strictures of the urethra. Omitting congenital strictures, which are comparatively rare, we may divide strictures etiologically into two groups: (1) Inflammatory, of which the vast majority are of gonorrheal origin, and (2) traumatic, most commonly due to "straddle injuries," such as falling astride some hard object.

The majority of all strictures of the urethra are of gonorrheal origin. In the future we will probably see fewer because of the fact that the majority of cases of gonorrhea respond to the sulfa drugs. Prior to the advent of the sulfa drugs, gonorrheal urethritis was treated locally and often overtreated because of the tendency of the disease to become protracted and fail to respond to routine measures.

Overtreatment locally has been in the past a prolific source of strictures, so much so in fact that Keyes was prompted to say that the gonorrheal victim's best chance to get well was to keep the physician out of the urethra.

Traumatic strictures, as a rule, are more serious than inflammatory because they are more rigid, less resilient and less amenable to dilatation. Furthermore, traumatic strictures have an unfortunate habit for some unknown reason of causing impotence in a high percentage of cases.

*Treatment.* Most strictures, whether inflammatory or traumatic, are located in the deep urethra, that is, the bulbomembranous portion. The posterior urethra (the prostatic urethra) is not subject to strictures. It is in the bulbomembranous urethra that

we find almost exclusively those strictures which gradually reduce the urinary stream to a dribble and finally complete retention,

The opening need be large enough only to admit the index finger. The Davis interlocking sounds<sup>1</sup> are now brought into

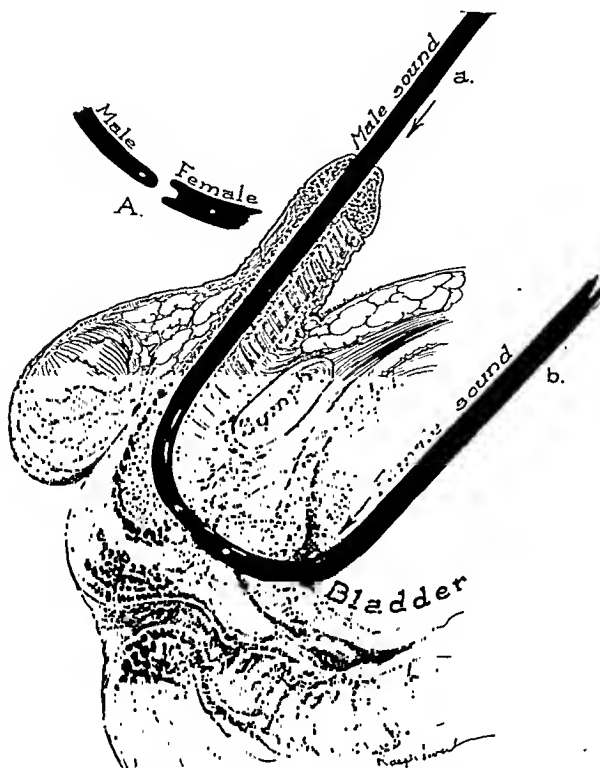


FIG. 1. Drawing to illustrate Davis interlocking sound technic applicable alike to impassable urethral stricture, and to rupture of the urethra. The male sound (a) passed per urethram contacts the female sound (b) introduced into the prostatic urethra through a cystotomy wound. When the two sounds are approximated the male then follows the female into the bladder without difficulty.

and at this point they may be complicated by peri-urethral phlegmon and urinary extravasation. These complications, of course, require adequate surgical drainage. As a rule, most strictures can be successfully dilated with sounds, or with filiforms and followers. If they do not yield to this treatment, it may be necessary to cut them from within (internal urethrotomy), using a urethrotome. If filiforms and followers cannot be passed to the bladder permitting internal urethrotomy, then the following simple procedure is indicated:

The patient is prepared for suprapubic and perineal surgery. Under low spinal anesthesia, with the patient in lithotomy position, a suprapubic cystotomy is done.

The male sound is passed through the anterior urethra as far as possible. The female sound is then guided into the posterior urethra through the suprapubic wound. By gentle manipulation the two sounds are brought together (Fig. 1), the male following the female up into the bladder. A Robinson double eye catheter, No. 20 to 24 F., is tied to the male sound (Fig. 2) which is withdrawn, pulling the catheter with it. This re-establishes the continuity of the urethra and the catheter is left in place as a retention catheter for seven to ten days before being withdrawn. This permits the suprapubic cystotomy wound to heal and maintains the patency of the urethra. After the catheter is with-

drawn the urethra is dilated with sounds first at weekly intervals then at lengthening intervals depending upon the patency and

suture material. Nature has fortunately endowed the urethra with wonderful powers of recuperation. With a retention catheter

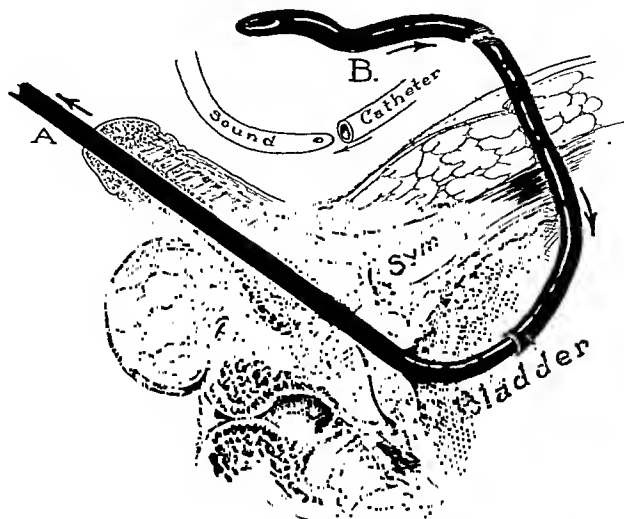


FIG. 2. Drawing showing end of male sound (A) in bladder. Female sound has been withdrawn and a catheter (B) is anchored to the male sound. The male sound is then withdrawn, pulling the catheter out through the urethra where it is left in place as a retention catheter for permanent drainage of the bladder per urethram. The cystotomy wound is allowed to close. After one to two weeks the urethral catheter is removed, and the patency of the restored urethra maintained by passage of occasional sounds.

caliber of the strictured area. The aphorism that a stricture is never cured is a true one, so that the passage of sounds may be required at intervals for an indefinite period.

In the event that the Davis interlocking sounds cannot be brought together because of the density and extent of an unyielding stricture, it is a simple matter since the patient is in lithotomy position, to palpate the ends of the two sounds in the perineum and to excise through a small midline perineal incision the scar tissue which prevents union of the sounds. (Fig. 3.) This may comprise an area 1 to 3 cm. in extent. Then the Davis interlocking sounds are brought together and the operation completed as outlined above.

Some authors make much of the necessity of approximating by suture the urethral mucous membrane of the distal and proximal segments after excision of the stricture. In my experience, this is a woeful and unnecessary waste of time and

in place acting as a splint the urethral mucous membrane will regenerate rapidly over a wide area, so that after a period of one to two weeks the urethral catheter may be safely removed and one will be rewarded with an intact patent urethra. Of course, one cannot wholly escape reformation of a certain amount of scar tissue so that occasional passage of sounds may be necessary as follow-up treatment.

The above described procedure accomplished with the aid of the Davis interlocking sounds is surprisingly easy to perform, and can be accomplished very quickly with a minimum of damage to normal structures. This is in direct contrast to the type of external urethrotomy advised by many authors, consisting of a difficult perineal dissection without resorting to the use of suprapubic cystotomy and the Davis interlocking sounds. No operation can be more difficult, and damage to the external sphincter or even the rectum

may result from floundering around in the perineum in the midst of a mass of scar tissue where normal landmarks are

sound technic and the suprapubic fistula eliminated.

Rupture of the urethra is included in

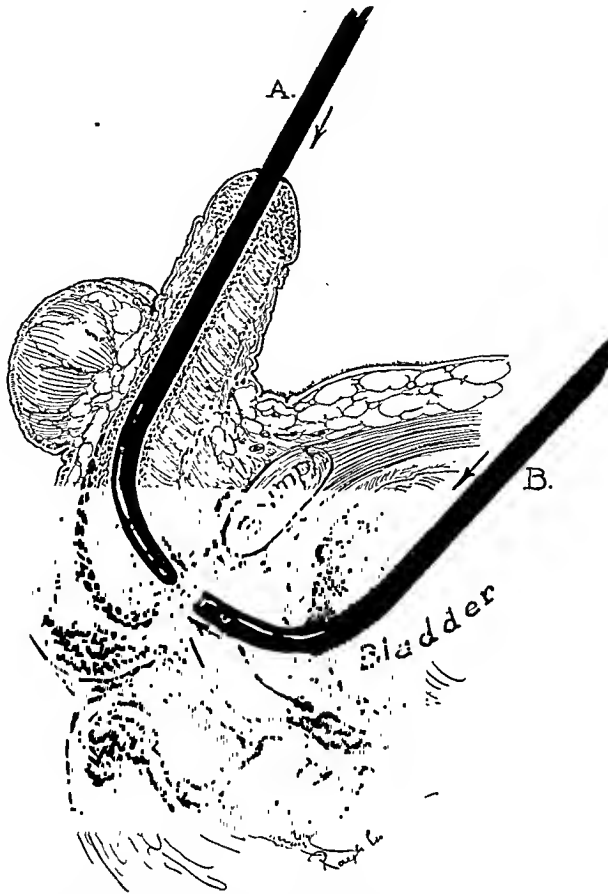


FIG. 3. Drawing to illustrate procedure in cases in which ends of sounds cannot be approximated. With the patient in extreme lithotomy position and sounds held in place by an assistant, it is easy to palpate their ends through the perineum and to excise the intervening scar tissue through a small midline incision. The sounds are then interlocked and the operation completed as described.

hopelessly distorted or lost, vainly seeking to identify and approximate the normal proximal and distal urethral segments. This statement holds for operations for rupture of the urethra as well as stricture of the urethra. A case in point is one recently seen by the author in which the patient had a previous unsuccessful external urethrotomy operation for impassable stricture and was condemned to permanent cystotomy drainage. The continuity of the urethra was very easily restored with the Davis interlocking

this dissertation because the treatment is exactly the same, namely, a preliminary suprapubic cystotomy followed by the use of the Davis interlocking sounds. As previously stated, trauma to the urethra is usually in the bulbomembranous area. The most common trauma is a "straddle injury" or a blow in the perineum. If the injury is mild, the urethra may not be actually ruptured but only bruised, so that the patient may still be able to urinate; but after a year or so the patient will develop complete retention as a late result

of the inevitable scar tissue formation which is bound to occur if the injury is of sufficient severity. As stated above, the management of traumatic stricture is exactly the same as for inflammatory stricture. Furthermore, if the injury is severe enough actually to rupture the urethra, the treatment again is exactly the same, namely, suprapubic cystotomy and the use of the Davis interlocking sounds. In the event of extravasation either of urine or blood or both, perineal incision is essential and more extensive incisions may be required for drainage if the extravasation is widespread.

Various authors quote mortality statistics as high as 40 or 50 per cent as a result of urinary extravasation incidental to rupture of the urethra and stricture of the urethra complicated by peri-urethral phlegmon and urinary extravasation. Prompt treatment as above outlined and the free use of the sulfa drugs locally and generally should greatly reduce this mortality rate. If a patient is in extremis when first seen, a two-stage operation may be necessary. This consists first of all in establishing suprapubic drainage, and multiple incision drainage of areas involved in extravasation. Since most strictures and injuries involve the bulbomembranous area, the extravasation will follow certain well defined planes conforming to Colles' fascia which confines it to the perineum and subcutaneous tissues of the scrotum. It may extend further up on to the abdomen as high as the axillae, since Colles' fascia is continuous with Scarpa's fascia. After one or two weeks the second stage may be accomplished quickly and easily with the Davis interlocking sound technic. As a typical example, I cite the case of a patient who had a stricture of the bulbomembranous urethra of some years standing. He subsequently suffered a blow to his perineum occasioned by the bumper of a truck. This resulted in complete retention and extravasation limited to the perineum and scrotum. He did not seek immediate medical aid and when first seen at the

hospital he was semi-comatose and was having frequent clonic convulsions. The bladder was drained suprapubically and the extravasated area drained. The prognosis at this point was very poor, but in a few days he rallied and two weeks after entry the second stage consisting of the Davis interlocking sound technic was consummated. He made a complete recovery, and at the present time his urethra readily accommodates a No. 28 F. sound without resistance.

The degree of associated infection is an important factor in mortality, especially in strictures in which peri-urethral phlegmon may be the precursor of urinary extravasation with anaerobic invasion of the tissues. Toxic absorption is extremely rapid and such cases require prompt treatment to save life.

Traumatic rupture of the urethra or even the bladder is not apt to be so rapidly fatal because the urine is often sterile. Sterile urine is not toxic or harmful to the tissues. As an example of this I cite the case of a man who came home intoxicated and fell over the foot of his bed rupturing a full bladder. He was brought to the hospital the next day and I was first called to see him that night. He had a board-like abdomen but no fever. Intravenous urography was negative. Cystoscopy revealed a large intraperitoneal tear in the fundus of the bladder with a loop of small intestine protruding through it. Immediate suprapubic cystotomy was performed and the rent sutured. The peritoneal cavity was opened and approximately 4,000 cc. of clear urine withdrawn. He promptly healed per primam with no febrile reaction. Although he was not operated upon until at least thirty-six hours after his injury, the peritoneum and intestines showed no redness or reaction of any sort as a result of having a belly full of urine.

Gross injuries of the lower urinary tract often complicate fractures of the pelvis and may constitute problems of great gravity. The bulbomembranous urethra may be ruptured but more commonly the



bladder is ruptured by force of the impact or torn by a spicule of bone. An extreme case of this nature was a man whose pelvis was crushed by a steam shovel. The bladder and prostate were completely torn away from the urethra and were floating free in the lower abdomen. This problem was handled by doing a cystotomy and inserting a Pilcher bag, the end of which was brought out through the urethra with the aid of the Davis interlocking sounds. The bag was distended and traction applied. This moored the bladder and prostate back in their normal positions and re-established the continuity of the urethra. An excellent ultimate functional result was obtained.

#### CONCLUSION

A simplified procedure for the treatment of impassable urethral stricture and rup-

ture of the urethra is described which practical experience has shown to be highly successful. The same fundamental principles of treatment characterized by simplicity and ease of performance are applicable to both conditions. These remarks may be interpreted as a testimonial to the Davis interlocking sounds, and rightly so, because they have brought order out of chaos and make it possible for the general practitioner as well as the specialist to manage these hitherto difficult cases with greater ease and success, with a consequent reduction in morbidity and mortality rates. Utilization of this procedure deserves emphasis at the present time because of the rising tide of industrial and war injuries.

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# TWO-STAGE MAMMAPLASTY IN RELATION TO BLOOD SUPPLY

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ONE of the chief potential dangers in mammaplasty is interference with the blood supply. The breast is a highly vascular organ and its surgical reconstruction usually demands the formation of skin flaps and glandular pedicles, during which process some vessels are likely to be severed. Unless adequate vascularization is preserved, necrosis of the skin and glandular structures will occur. A clear understanding of the vascular distribution is essential to prevent this.

Unfortunately many inaccuracies have crept into the literature on this subject: the classical description of the old anatomists errs on many points and most of the modern authors until a few years ago, including the writer, accepted these faulty data.<sup>1</sup> Since the use of roentgenographic studies of injected vessels, however, a more complete and accurate picture is available. The chief difference lies in the larger rôle attributed to the thoracic lateral artery in mammary vascularization.

The writer has elsewhere described fully the arterial blood supply of the breast as revealed by recent investigations.<sup>2</sup> This paper will discuss the author's two-stage procedure in relation to some of the salient features of mammary vascularization.

## MAIN SOURCES OF VASCULARIZATION\*

The blood supply of the breast has three main sources. (Fig. 1.) (1) The internal mammary artery, originating from the subclavian; (2) the thoracic lateral, branch of the external mammary artery; (3) the intercostal arteries, originating from the aorta, (of secondary importance).

The degree in which these different vessels participate in the vascularization

of the breast varies with the individual, but there are always at least two main sources. The most frequent combinations are: (1) The internal mammary artery and the thoracic lateral artery (50 per cent of cases); (2) the internal mammary artery and the intercostal arteries (30 per cent). (3) the internal mammary artery, the thoracic lateral artery and the intercostals (about 18 per cent).

*The internal mammary artery* is the main artery of the breast and usually sends out two types of ramifications, anterior and posterior perforating branches (i.e., with respect to the gland). The distribution and location of the anterior perforating branches of the internal mammary are of definite practical importance in mammaplasty. (Fig. 2.) According to recent studies, the inner intercostals on the posterior aspect of the gland derive from the internal mammary artery and not from the aorta, as was long supposed.<sup>3</sup> Their disposition and origin make posterior resection of the gland the safest one, as it does not disturb the main anterior vascular pedicles. (Fig. 2.)

*The Thoracic Lateral Artery.* The majority of anatomists agree on the predominance of the internal mammary artery in the vascularization of the breast. Recent investigations prove beyond doubt that the thoracic lateral artery also participates largely in mammary vascularization. In fact, some investigators consider its participation in the vascularization of the gland and nipple universal, though others limit it to about 55 per cent of cases.<sup>2</sup>

It is important to note that in about 13 per cent of cases, the thoracic lateral artery plays a predominant part in the vascularization of the gland. Consequently, its sacrifice through excision of the lateral

\* Only arteries are described here as the veins usually follow a similar course.

half of the breast\* may result in necrosis of the central part of the gland, including the nipple. (Figs. 3 and 8.)

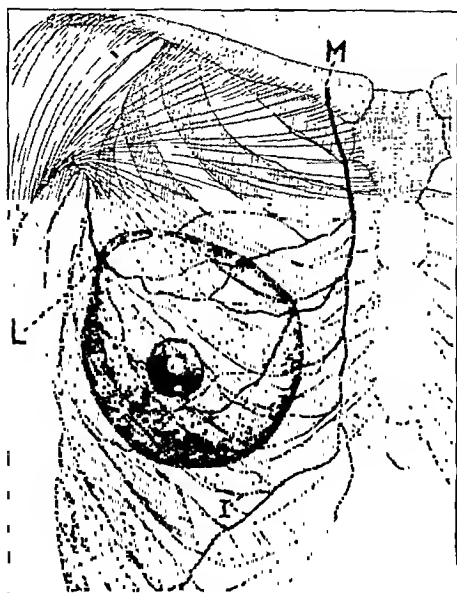


FIG. 1. Main vascular pedicles of the breast, according to the present day concept of its blood supply (diagrammatic). Note the numerous anastomotic branches above and below the nipple. The deeply located ramifications are represented by dotted lines. L, the thoracic lateral artery and its two main ramifications on the external aspect of the gland; M, internal mammary artery with its perforating anterior branches; I, intercostal arteries.

#### PERIAREOLAR VASCULAR TOPOGRAPHY

The nipple and the central parts of the gland are particularly subject to necrosis in certain reparative procedures. In approaching the nipple, branches of the main arterial pedicles form two anastomotic plexuses, one superficial, the other in the depth of the gland. Roentgenographic studies of injected vessels of the breast reveal the following main types:

1. The *circular periareolar plexus*, in which ramifications of the main vascular pedicles form almost a complete ring around the nipple. This variety found in about 70 to 74 per cent of cases, assures maximum blood supply and can be considered the safest from the viewpoint of possible necrosis. In the presence of a

\* Biesenberger's method of mammoplasty.

circular anastomosis, semi-circular resection of the breast will not compromise the vitality of the nipple. (Fig. 4.)



FIG. 2. Vascular topography on posterior aspect of breast. The intercostal arteries are long and penetrate the gland by short ramifications; this permits their easy retraction in the posterior approach of the gland. Note that the inner intercostal arteries, IM, originate from the internal mammary artery, (M); I, intercostal arteries (aorta) of secondary importance; L, thoracic lateral artery.

2. The *loop type plexus* has been observed in about 20 per cent of breasts examined.<sup>2</sup> Here the thoracic lateral artery predominates and resection of the internal half of the gland in a mammoplasty is usually safe. The formation of an internal glandular pedicle, on the other hand, may result in necrosis of the nipple by reducing the blood supply of that area to a dangerous degree.

3. The *radial type plexus* is characterized by the lack of any ring or loop formation around the nipple. (Fig. 5.) The branches from the two main sources are directed toward the nipple at a distance from each other, without anastomosis between them and their main arterial pedicles. This type is found in about 6 per cent of cases. Here deep lateral glandular excision in the areolar zone will necessarily sever the main source of blood supply to the corresponding

part of the breast and almost invariably produce necrosis of the nipple for lack of anastomotic compensation.

included to avoid injury to the main vascular branches located subcutaneously.

3. Excision of the internal half of the

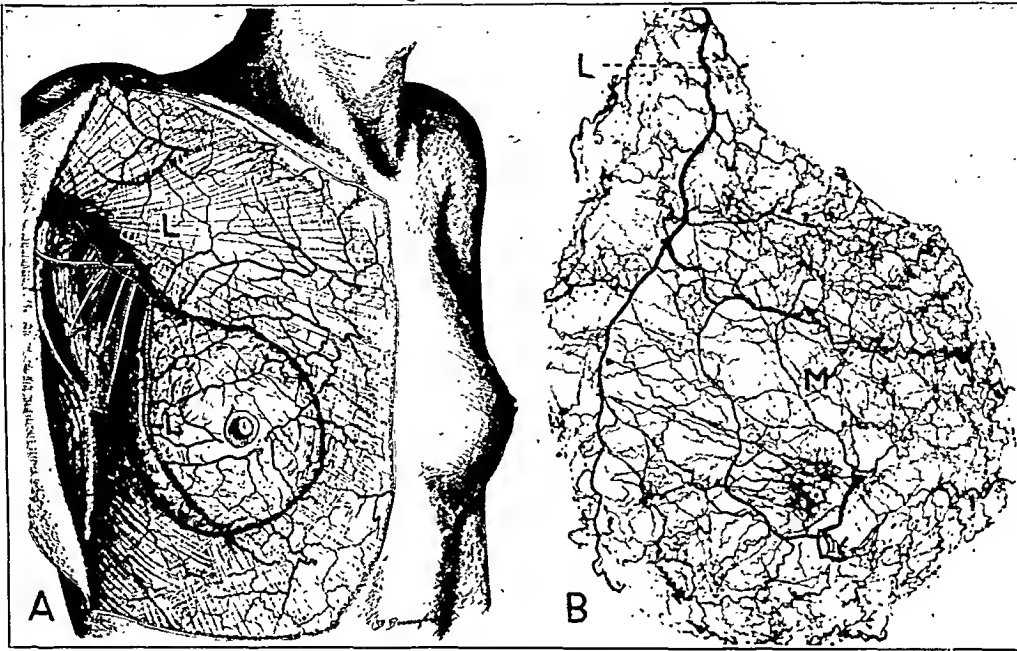


FIG. 3. A, thoracic lateral artery and its topography. Two main branches (L) follow the external aspect of the gland. Note the numerous anastomoses above and below the nipple with the branches of the internal mammary artery. B, thoracic lateral artery, a frequent variety of overdevelopment. Injected right breast of a woman of twenty-two, deprived of cutaneous covering (Salmon). The thoracic lateral artery (L) is here well developed and supplies more than half of the gland. The main perforating branch of the internal mammary artery (M) is small. Resection of the external half of the breast in the course of a mammoplasty in this case could sufficiently disturb the blood supply of the central zone of the gland and nipple to bring about their necrosis. In about 13 per cent of cases, the thoracic lateral artery plays a predominant part in vascularization of the breast.

As it is impossible, prior to surgery, to foretell which type of vascularization will be encountered, all eventualities must be kept in mind in appraising a surgical procedure.

#### STEPS FOR PRESERVATION OF BLOOD SUPPLY IN SKIN AND GLANDULAR PEDICLES

On the basis of revised anatomical data,<sup>2</sup> the following precautions must be observed for the preservation of blood supply in skin and glandular pedicles:

1. Incisions made in the periareolar area must be superficial, with intradermic resection of the areolar skin.

2. In the preparation of skin flaps, adequate subcutaneous tissue must be

breast should be avoided because of the fact that the internal mammary artery is the main artery to the gland.

4. Resection of the external half of the breast is also contraindicated because of the danger of interference with the important vascularization supplied by the thoracic lateral artery. Gillies and McIndoe,<sup>4</sup> who describe the use of an internal glandular pedicle following resection of the outer half of the breast by a method similar to Biesenberger's, report local complications in 22.5 per cent of a series of eighty cases. The writer abandoned a similar method many years ago after encountering partial and total unilateral necrosis of the nipple in four out of twenty-three cases in which the external half of

the breast had been resected. The fact that the necrosis occurred on one side only confirms the presence of vascular

gland and nipple, interference with the vascular system is likely to occur. (Fig. 8.)

It has been proved, as stated above,

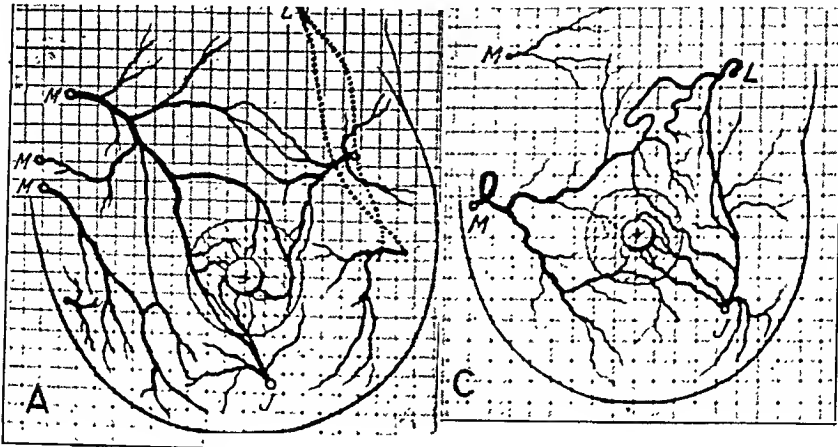


FIG. 4.

FIG. 4. A, the branches of the main arterial pedicles form a complete ring around the nipple. This is the safest type of vascularization from the viewpoint of possible necrosis. It is found in about 70 to 74 per cent of cases. J, intercostal artery; L, thoracic lateral artery; M, internal mammary artery.

FIG. 5.

FIG. 5. C, radial type of periareolar plexus characterized by the lack of anastomotic formations between the branches of the main arteries directed toward the nipple. This arterial disposition was found in 6 per cent of injected vessels of the breast. In such instances an extensive resection of the gland done simultaneously with a circular incision around the nipple will in all probability be followed by its necrosis. Because of this danger, all one-stage mammoplasties based on extensive resection of the gland should be condemned. M, internal mammary artery; L, thoracic lateral artery; J, intercostal arteries.

asymmetry, as identical procedures were carried out on both breasts.

5. If excision of glandular tissue is necessary, it is best done in the "safety zones" of the gland, namely, in the midline between the main vascular pedicles (upper quadrants) and in the external lower quadrant. (Fig. 6.)

The following two-stage procedure conforms to the principles enumerated above and embodies maximum safety factors.

#### UNDERLYING PRINCIPLE OF THE TWO-STAGE PROCEDURE

Surgical reconstruction of the breast should be done in two stages to permit safe transposition of its central portion prior to any extensive resection of the skin and glandular structures which might interfere with the blood supply. If wide excision of breast tissue is made simultaneously with transposition of the central part of the

that there is lack of uniformity in the vascularization of the breast and that reliance on the predominance of one vascular pedicle over another is dependent on guesswork. Although the internal mammary is the predominant artery in the majority of cases, the thoracic lateral artery may predominate in a certain percentage. When large sections of breast tissue are excised, there is risk of excessive diminution of the blood supply of the remaining gland with consequent necrosis of the part. Our inability to foresee the actual distribution of the blood supply in any one case necessarily dictates caution in all. (Fig. 3.)

In the two-stage operation, the transposition of the central portion of the breast is done first with no disturbance of the blood supply. Six to eight weeks later, excess glandular tissue can be removed with complete safety. Division of the

surgery into two stages not only eliminates all danger of necrosis, but contributes to a more esthetic end result, since the final re-adjustment of shape and form can be done without haste during the second stage. An additional advantage is the lessening of operative shock.

The writer has employed this two-stage procedure since 1929 with few modifications.<sup>6</sup> In 193 cases, total necrosis of the nipple has never been encountered. In our early experiences, localized skin sloughs occurred mostly along the edges of the flaps and around the nipple, as a result of making the skin flaps too thin or suturing them under undue tension. Since the employment of thicker flaps, no skin necrosis of any extent has taken place.

*Preoperative Preparation.* The general condition of the patient should be thoroughly checked and surgery done only if the individual is physically and mentally fit. The skin must be carefully prepared especially in the submammary region, which is frequently the seat of irritation caused by excessive perspiration. General anesthesia is administered routinely.

*Preoperative Markings.* Many methods have been described for proper location of the transposed nipples. The author draws vertical and horizontal lines, respectively, through the middle of the clavicle and the upper arm; their intersection approximately determines the position of the nipple. Many other factors must also be taken into consideration, such as the size of the chest, the height of the individual, etc. An artistic appreciation of the region is probably still the best guide for tracing the landmarks.

One of the most common mistakes with regard to the new location of the nipples is a tendency to place them asymmetrically too high or too near the sternum. The size of the buttonhole necessarily depends on the size of the transposed areola. An excessively large areola must often be reduced prior to transposition and the buttonhole outlined accordingly. To avoid excessive

tension on the nipple, an allowance of 2 to 3 mm. in the diameter of the new implantation is made.

#### OPERATIVE PROCEDURE\*

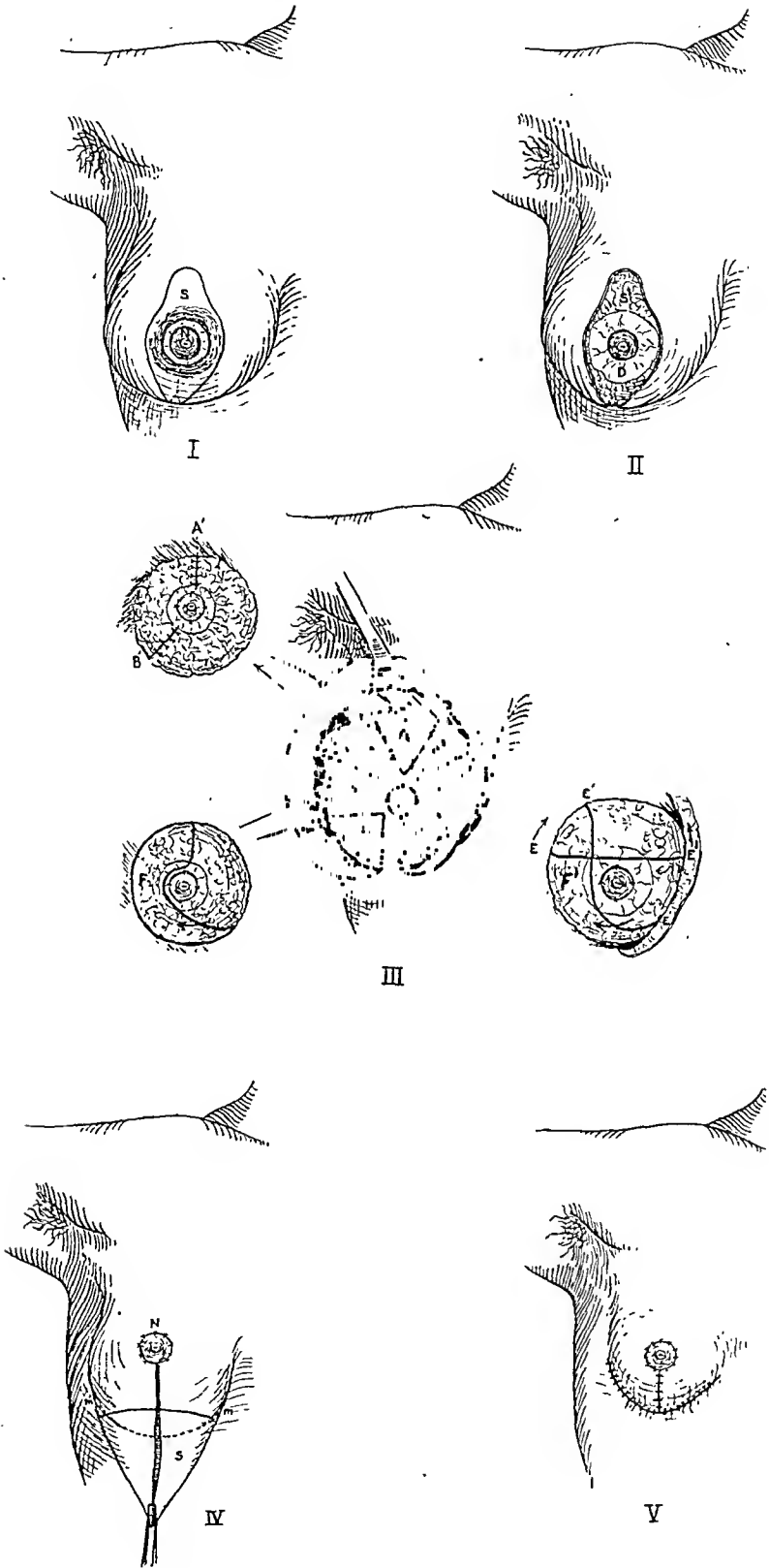
1. A *periareolar incision* is so made as to outline a normally shaped areola of circular form. The size of the outlined areola varies according to the individual. Generally the pigmented area in hypertrophied breasts is much too large and requires reduction. (Fig. 6.)

Dissection of the fine areolar skin is done superficially to preserve the arterial and venous plexuses located in close contact with the derm; it is carried out intradermally, avoiding the subcutaneous layer. Injury to the vascular plexus during this stage must be followed by thorough hemostasis to prevent the formation of hematoma.

Traumatization of the nipple by rough handling with instruments must be avoided. Following the circular incision, the retracted areolar skin is temporarily affixed to the deep structures at the ends of the horizontal and vertical diameters to prevent its separation on handling the gland.

2. *Preparation of Skin Flaps.* For the upper skin flaps, which the writer uses in most of the marked hypertrophies, a horizontal incision is made directly above the areolar zone, with a slight concavity directed upward. It must be ascertained from the beginning that the outlined subareolar skin is of sufficient height to permit its suturing in the submammary fold in the second stage. In moderate ptosis this is impossible as the buttonhole is made low and the horizontal suture line must, therefore, be placed above the submammary fold. That is one of the reasons why the double flap is preferable to the single upper flap in the repair of medium sized hypertrophies and simple ptosis. (Figs. 6 and 7.)

\*A detailed description has been published elsewhere;<sup>6</sup> this paper stresses modifications of technic developed since.



For descriptive legend see opposite page.

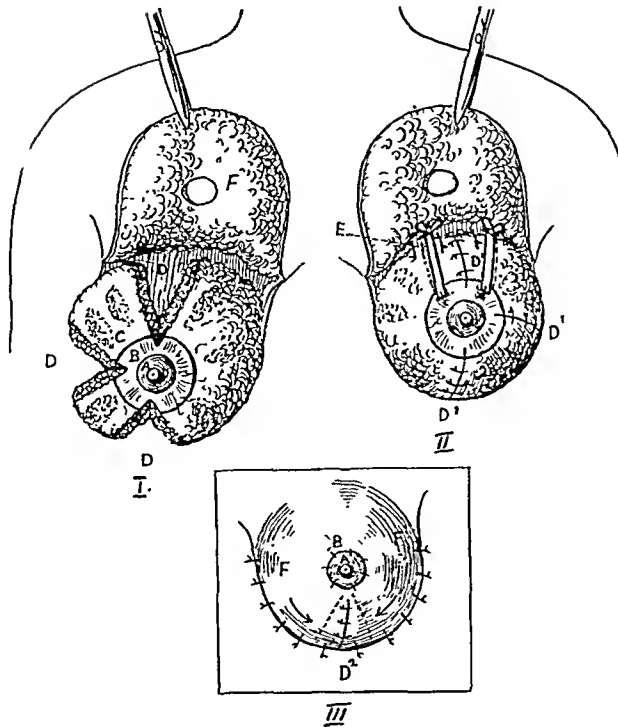


FIG. 7. Mammoplasty showing fenestrated upper horizontal flap with safe wedge-shaped mammary excisions. I, B, periareolar derm left attached to the gland to preserve the central vascular plexuses; D, safe wedge-shaped glandular excision; F, fenestrated horizontal flap with attached subcutaneous tissue. II, suspension and affixation of the reduced gland. D¹, closure of glandular defects; E, dermal loops obtained from discarded mammary skin after removal of epidermis. These loops extending from the dermal disc to the pectoral fascia assure good affixation of the ptosed gland. III, reduction of horizontal diameter of breast; F, F¹, in second stage by midline excision, D².

FIG. 6. Open transposition of central mammary segment with midline resection of skin flaps. Procedure especially indicated for ptosed breasts of medium sized hypertrophy, requiring good affixation. I, midline skin excision (s) with formation of two lateral flaps. Areola reduced in size leaving nipple (N) firmly attached to periareolar derm. II, s¹, central skin defect. Lateral flaps are bluntly undermined to expose the gland to the second intercostal space. D, periareolar plexus left intact together with a dermal zone following superficial excision of areolar skin. III, safe and dangerous glandular resections. A, B, safe wedge-shaped resections in the upper and lower lateral quadrants avoiding injury to the main vascular pedicles of the thoracic lateral artery and internal mammary artery. A¹, B¹, closure of glandular defects and affixation to the pectoral fascia. a, a¹, unsafe wedge-shaped resections in the areas of the main vascular pedicles of the gland. (See Fig. 7.) E, E¹, resection of upper half of the gland, unsafe for the same reason as above. F, external resection of gland with upward rotation of an internal pedicle (Gillies, McIndoe). F¹, extent of external resection in procedure of Biesenberger. These procedures are contraindicated because of sacrifice of the blood supply reaching the nipple from the thoracic lateral artery, which often is the main artery of the gland; necrosis of the nipple sometimes follows these methods. IV, N, nipple sutured in upper pole of skin defect; m, m, full and dotted lines along which the lateral flaps are excised. v, final reversed T-shaped suture line.



Although the incision of the flap must be long enough to permit free exposure of the anterior aspect of the breast, it is

the flaps. To avoid injury to the main branches arising from the two pedicles, particularly the internal mammary artery)



FIG. 8. A, necrosis of right breast in girl aged twenty-two following one-stage mammoplasty for fatty hypertrophy, done elsewhere. Right breast prior to surgery had been similar to left shown here. The excision of the external half of the gland simultaneously with transposition of nipple sufficiently disrupted the blood supply to bring about sloughing of the central part of the breast. B, a two-stage mammoplasty was done by me on the left breast: transposition of its central segment in a buttonhole of an upper horizontal flap in first stage with final shaping of mammary structures in a second stage. Wedge-shaped glandular excisions were made in midline between the two upper quadrants and from the lower external quadrant. Scar excision and tattooing of nipple on right breast.

advisable not to extend same toward the midline or far into the axilla in order to prevent excessive scarring. Wide excision of skin from the posterior aspect of the breast is avoided during the first stage to eliminate any disturbances in vascularization of the nipple through undue tension.

The single horizontal skin flap has definite advantages over the double flap with regard to blood supply. At first I prepared this flap rather thin on the assumption that the anterior blood supply would be preserved by leaving the subcutaneous fat attached to the gland. However, experience demonstrated that, in view of its length, this flap must be thick enough to retain the cutaneous branches of the vascular pedicles. Since their depth is approximately 1 to 1½ cm., this should be the minimum thickness of

the dissection of the flap is done bluntly with a gauze sponge. The use of sharp instruments should under all circumstances be avoided as it entails needless bleeding. The undermining of the upper flap extends to the second intercostal space, where the affixation of the upper pole of the gland is done. (Fig. 7.)

As a rule the shape of the breast should be outlined by the glandular structures and not by an excessively stretched skin, which is unsuitable for the maintenance of the mammary contour and is likely to give way under moderate weight or pressure. Recurrences following mammoplasty will be prevented by not placing too much reliance on the skin as a means of maintaining the mammary structures. The necessary reduction of the gland itself and its adequate affixation to the pectoral

fascia are the only means to obtain and insure the proper shape of the breast; the skin should merely provide an evenly dis-

tributed covering for the reconstructed parts. the second stage by excision of excess skin in the midline and along the submammary fold simultaneously with a wedge-shaped

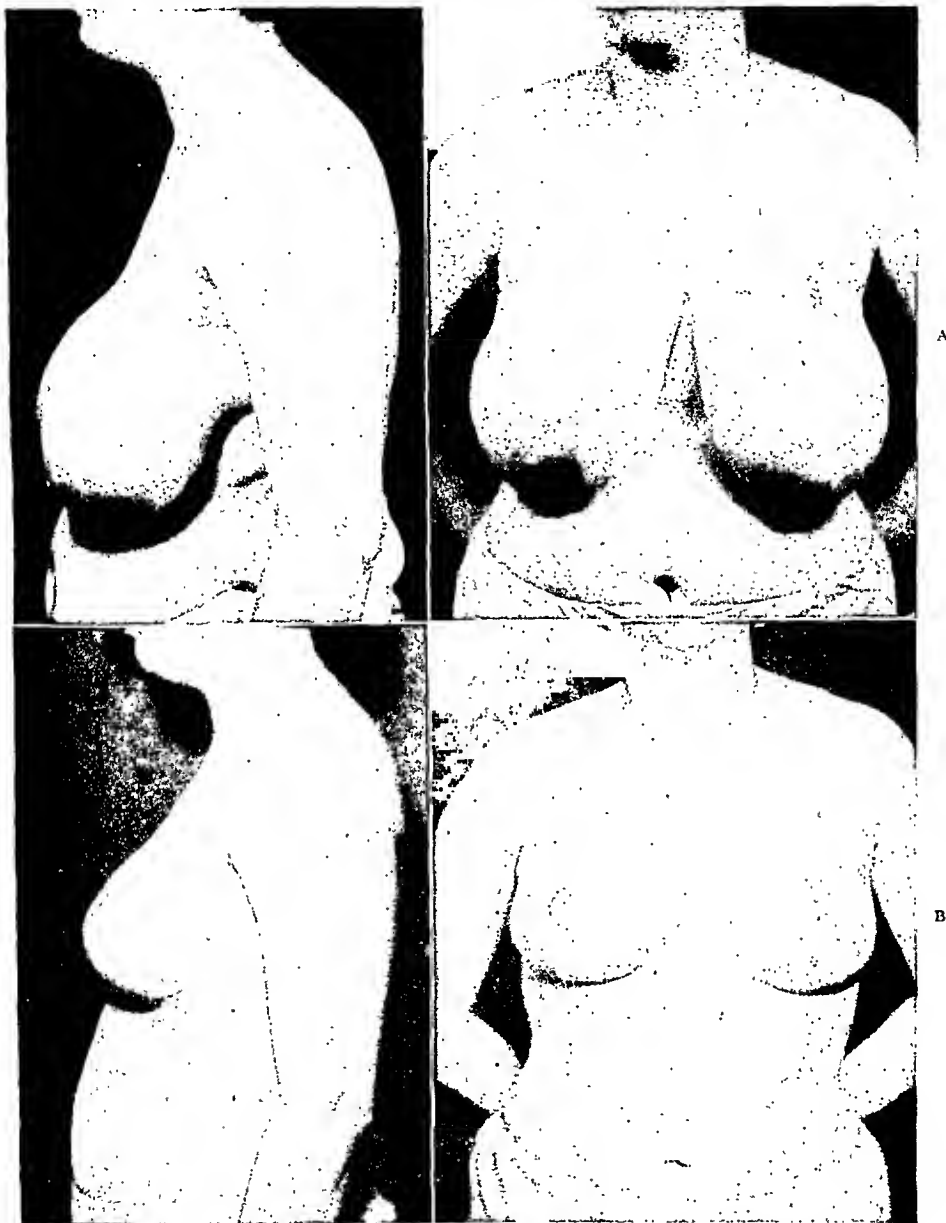


FIG. 9. A, marked hypertrophy and ptosis in a girl aged twenty-four, overweight, but without history of glandular disturbance. Note distended venous plexus visible under thin skin and also the faulty posture due to the weight of the breast. B, mammaplasty in two stages with glandular wedge excision between upper quadrants done in first stage and excess skin and gland resection in midline of lower quadrants in second stage.

tributed covering for the reconstructed parts.

A disadvantage in the use of the single horizontal flap is the resulting excessive width of the breast. This is remedied in

glandular excision from the lower external quadrant. (Figs. 9 and 10.)

The double skin flap is indicated in moderate ptosis repaired in a single-stage procedure. Its preparation is based on the

same principles as govern the outlining of the upper single flap. To bring about an even distribution of the skin covering over the affixed gland, it is necessary to under-

and the two suture lines are superimposed. This can be partly avoided by excision of a glandular wedge from the lateral quadrant rather than in midline. (Figs. 6 and 11.)

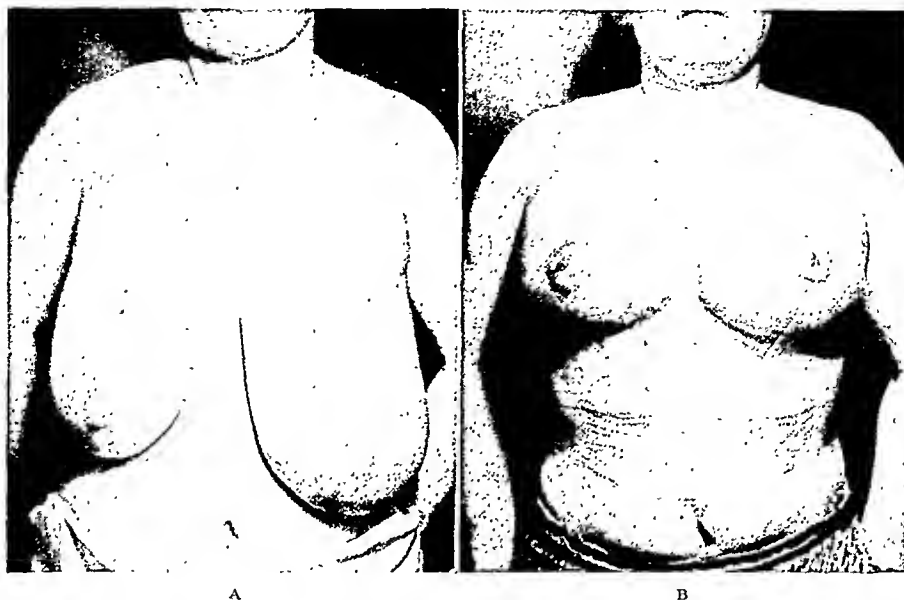


FIG. 10. A, asymmetrical hypertrophic breasts with mastitis in a woman, aged thirty-seven. Rapid growth of both breasts followed two pregnancies. The patient being of rather small stature, complained mainly about the weight of the breasts which caused pain in the shoulders and faulty posture. Numerous nodules were felt in both breasts, some the size of an egg. Two large masses were present in the external quadrant of the left breast extending from the center toward the axilla. B, following a two-stage mammoplasty. In the first stage simultaneously with transposition of the nipple in a buttonhole of a horizontal skin flap, two cystic fibromas weighing 690 Gm. were removed from the left breast and numerous nodules of smaller size from the right one. Histology revealed marked hyperplasia of the ducts and hypertrophy of the breast acini. Patient seen eight years after surgery presents well maintained breasts without recurrence of fibromas.

mine the two lateral flaps widely, through a vertical incision extending from the nipple toward the submammary fold. The extent of the horizontal skin excision in the submammary fold will depend on individual requirements. The resulting scar will be an inverted "T." (Fig. 6.) It should be kept in mind that, in the open transposition of the central part of the gland, the blood supply of the flaps is reduced by the midline incision. When they are made thin and sutured under tension in a single-stage procedure, superficial sloughing of the skin along the edges is liable to occur. This is particularly true when glandular excision from the lower quadrants is carried out at the same stage

3. *Glandular Pedicles.* In large hypertrophies, if necessary, a wedge-shaped excision can be made in the first stage in the central segment of the upper half of the gland. This entails small jeopardy to the two main vascular pedicles. (Fig. 6.) The resulting glandular defect is closed with plain catgut and the gland itself affixed to the pectoral fascia, preferably with dermal loops. Any further reduction in the size of the gland during the first stage is inadvisable. (Fig. 7.)

The final reduction of glandular structures is carried out at the second stage, when any amount of breast tissue can be removed with safety after the "take" of the transposed central segment.

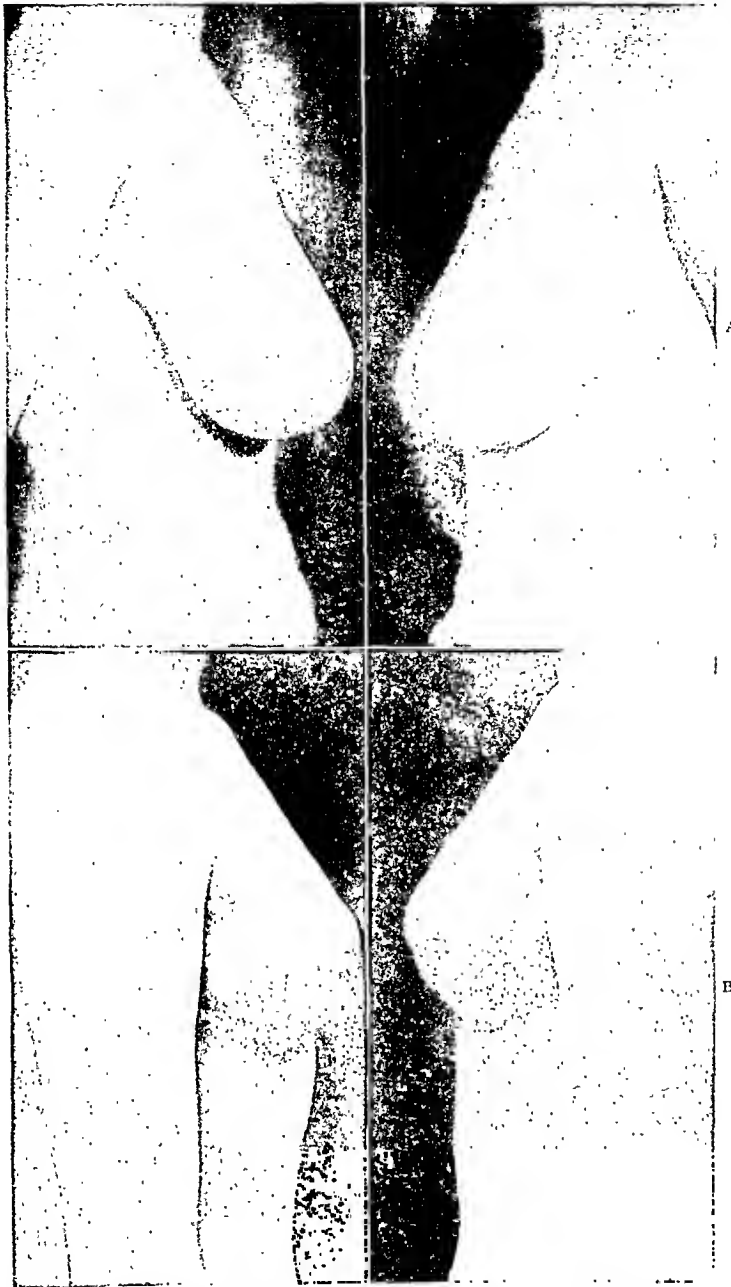
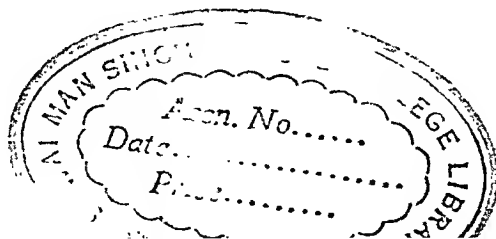


FIG. 11. A, ptosis of otherwise normal breasts, due to mechanical pressure of tight brassieres in a girl of twenty. The deformity was brought about by a desire to hide the breast protrusion, the patient being a dancer. B, mammaplasty by open transposition of the central part of the gland in one stage. The two lateral flaps were sutured in midline and along submammary fold leaving a reversed T scar. Because of the weakness and distention of the suspensory apparatus in these cases, a thorough mastopexy to the pectoral fascia with dermal loops is indicated. (See Fig. 7.)



In hypertrophies with excessive protrusion, a discoid resection from the posterior aspect of the breast can be done.<sup>7</sup>

#### SUMMARY AND CONCLUSIONS

1. The blood supply of the breast is provided by three main sources: the internal mammary artery, the thoracic lateral artery and the intercostals. The safety of mammaplasty depends on the preservation of adequate vascularization.

2. In approximately 55 per cent of cases, the thoracic lateral artery has an equal part, and in 13 per cent a predominant part, in vascularization of the gland. Failure to respect the rôle of the thoracic lateral artery leads to wide excisions of glandular structures, with resultant necrosis.

3. Among the three types of periareolar plexuses, the circular type (74 per cent) is the safest one in relation to mammaplasty. The radial type (6 per cent) is the most dangerous because of lack of anastomosis between the periareolar ramifications of the main arteries. Since it is impossible to foretell which variety will be encountered in a given case, the method of choice must be potentially safe in all.

4. In large hypertrophies, mammaplasty should be carried out in two stages. The first stage consists of subcutaneous trans-

position of the central part of the breast and nipple and wedge-shaped excision from the upper pole of the gland. Final removal of excess glandular tissue and redundant skin is done in the second stage after the "take" of the transposed part. The danger of necrosis is thus eliminated.

5. A single upper skin flap is the safest for use in the first stage in marked hypertrophies. A double flap is preferable in moderate ptosis; here the procedure may be carried out in one stage.

6. The shape of the breast should be outlined by properly adjusted glandular structures and not by an excessively stretched skin which is unsuitable for the maintenance of the mammary contour.

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# RENAL ECTOPIA\*

## A STUDY OF TWENTY-THREE CASES

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THE ectopic kidney is of clinical interest and importance to the abdominal surgeon and gynecologist no less than to the urologist. It may produce bizarre symptoms and is often confused with other abdominal and pelvic tumors. The singular importance of the solitary pelvic kidney (ectopia with contralateral agenesis) and of the unilateral fused kidney (crossed-fused ectopia) to the abdominal and pelvic surgeon are obvious. Their urological significance has been emphasized repeatedly. There is little danger of renal ectopia being overlooked or of accidents occurring, however, if urological disease has been suspected and examination of the urinary tract performed. It is well, therefore, to be aware of the condition and its manifestations.

The series of cases reported here was studied to check the various statistical facts of interest and to determine the relative frequency and clinical importance of the several types of renal ectopia. Few large series have been reported, that of Thompson and Pace<sup>1</sup> (1937) being the largest and most important. Certain forms of renal ectopia also are sufficiently rare to justify individual case reports. One instance of each of the following types are included among the cases reported here: bilateral renal ectopia; crossed, unfused ectopia; and ectopia with contralateral renal agenesis (solitary pelvic kidney).

**Definition.** Ectopia implies congenital displacement. Renal ectopia may be of several degrees and types. There are three general levels which the displaced kidney may occupy: the low lumbar region or iliac fossa (Fig. 1); on the brim of the

pelvis; or below the brim of the pelvis, the true pelvic kidney. (Fig. 2.) The lower the kidney, the nearer the midline it

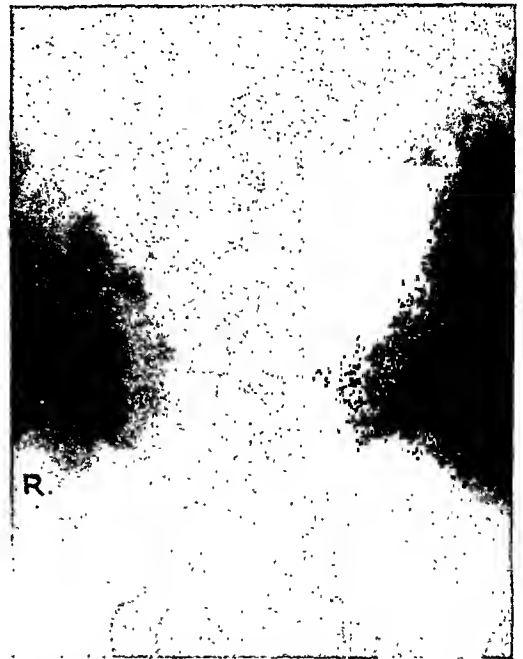


FIG. 1. Bilateral retrograde pyelogram of Case 8. Right renal ectopia; low lumbar position. Note short right ureter excluding renal ptosis.

usually lies. Ectopia may be unilateral or bilateral. Both kidneys may occupy a pelvic position and be fused to form a "cake" or "shield" kidney, one of the rarest forms. The kidney may be displaced to the opposite side of the body from its natural position. Such a kidney may then be fused with or lie distal to the other kidney. This is crossed ectopia, fused or unfused, the former being much more common. (Fig. 3.) Crossed ectopia is differentiated from renal duplication with contralateral renal agenesis by the fact

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that the two ureters open on opposite sides of the trigone.

*Incidence.* Studies of various autopsy

subject. The obstruction to ascent by the many blood vessels, particularly the umbilical arteries, is frequently referred to.

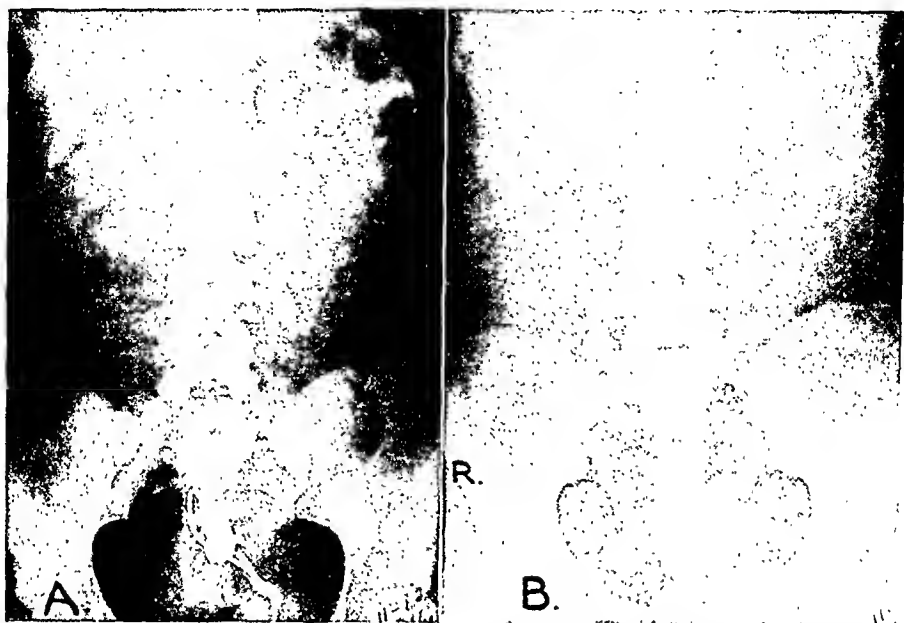


FIG. 2. Pyelograms of Case 12: solitary left pelvic kidney. A, retrograde pyelogram; B, excretory urogram showing filling of left pelvic kidney and bladder with no dye in right renal area.

series indicate the incidence of all types of renal ectopia to vary from 1 in 500 to 1 in 1500 necropsies. The clinical incidence is considerably greater. Some forms of renal ectopia are rare. Fowler<sup>2</sup> (1941) reported four cases of bilateral renal ectopia, bringing the total number of such cases to forty. Wilmer<sup>3</sup> (1939) collected 285 cases (with his five) of unilateral fused kidney. Pagel<sup>4</sup> found 14.5 per cent of crossed ectopic kidneys to be unfused in a series of fifty-five cases. Langworthy and Drexler<sup>5</sup> (1942) could find only 20 instances of crossed unfused renal ectopia in the literature. McCrea,<sup>6</sup> in 1942, reported a case of solitary pelvic kidney, bringing the total number of these cases to 35 at that time.

*Etiology.* The cause of renal ectopia is unknown. Many factors are probably operative in producing the condition; these may be extrinsic as well as intrinsic. Anson, Pick and Cauldwell<sup>7</sup> (1942) recently cited most of the references to the

This may also force the two metanephric masses into contact and result in fusion (Boyden<sup>8</sup>). Crossed ectopia without fusion is difficult to explain.

#### ANALYSIS OF CASES

Twenty-three cases of renal ectopia were studied. Fifteen of these were autopsy observations and eight clinical. These were all of the cases, through 1942, indexed under this diagnosis at the Los Angeles County General Hospital. There are reasons to believe that some cases have been missed, so no calculations of incidence have been made. These cases are presented in Table 1.

*Sex.* Sex has not been considered an important factor in renal ectopia. In this series thirteen (56.5 per cent) were females and ten (43.5 per cent) were males. Of the fifteen autopsy cases eight (53.4 per cent) were females. Approximately 40 per cent of the autopsy series as a whole were females; so that the incidence of renal

ectopia in females was 13 per cent higher than in males.

*Age.* The age distribution of all patients studied is shown in Table 11. Of greater interest is the age of the patients seen clinically. Five (62.5 per cent) of these eight patients were under thirty years

occur more commonly on one side than the other and this is not true of unselected cases. Ten (43.5 per cent) of the cases reported here involved the right kidney, twelve (52.2 per cent) the left, and one (4.3 per cent) was bilateral. The distribution between right and left kidneys

TABLE I  
SUMMARY OF CASES OF RENAL ECTOPIA

Case No.	Sex	Age in Years	Autopsy or Clinical	Side Involved	Position	Disease or Other Congenital Urinary Tract Abnormality	Disease or Abnormality of Opposite Kidney
1	Female	24	Clinical	Right	Crossed-fused	None	None
2	Female	64	Autopsy	Left	Pelvic	None	None
3	Male	83	Autopsy	Right	Crossed-unfused	None	None
4	Female	47	Autopsy	Bilat	Both iliolumbar	Right bifid pelvis	No disease
5	Male	55	Autopsy	Left	Lumbar	None	None
6	Female	*	Autopsy	Left	Crossed-fused	None	None
7	Female	43	Clinical	Left	Pelvic	Hydronephrosis and tubular degeneration	Hydronephrosis
8	Male	15	Clinical	Right	Lumbar	Pyelonephritis	Pyelonephritis
9	Female	35	Clinical	Left	Pelvic	Pyelonephritis	Pyelonephritis
10	Male	50	Clinical	Left	Pelvic	None	Ureteral calculus
11	Female	29	Clinical	Right	Pelvic	Pain and infection	None
12	Female	21	Clinical	Left	Pelvic	None	Absent
13	Male	23	Clinical	Right	Pelvic	Ectopic ureteral orifice	Malrotation
14	Male	38	Autopsy	Left	Iliolumbar	Partial duplication of kidney and ureter	None
15	Female	41	Autopsy	Left	Pelvic	None	None
16	Male	†	Autopsy	Left	Pelvic	Ureter blind distally	None
17	Female	71	Autopsy	Right	Pelvic	None	Partially calcified
18	Female	65	Autopsy	Right	Pelvic	None	None
19	Male	35	Autopsy	Right	Iliolumbar	None	None
20	Female	69	Autopsy	Left	Pelvic	None	Partial renal duplication
21	Female	29	Autopsy	Right	Lumbar	Bifid pelvis	None
22	Male	7	Autopsy	Right	Crossed-fused	Chronic glomerulonephritis	Glomerulonephritis
23	Male	‡	Autopsy	Left	Iliolumbar	Upper pole connected to lower pole of right kidney by 2 anomalous veins	Bifid pelvis

\* 18 hours.

† Still-born.

‡ 22 months.

of age. Of the other three, one was thirty-five, one forty-three, and one fifty. Thus, as with other congenital lesions of the urinary tract, the condition becomes manifest early in life if it is to cause trouble.

*Side.* The side involved may be of greater importance with some of the particular types of renal ectopia than with ectopia in general. At least, some of the forms of renal ectopia are reported to

was not influenced by whether the observations were made clinically or at autopsy.

*Position.* The position of the ectopic kidney in twelve cases (52.2 per cent) was pelvic, in four (17.4 per cent) iliolumbar, and in three (13.0 per cent) lumbar. One of the instances of iliolumbar ectopia was bilateral (Case 4). In one of the cases of pelvic kidney (Case 12) there was congenital absence of the opposite



kidney (previously reported (Nation<sup>9</sup>). (Fig. 2.) In four cases (17.4 per cent) there was crossed ectopia; three of these



FIG. 3. Excretory urogram of case of crossed left renal ectopia, apparently fused (patient of Dr. Lyle G. Craig). Left ureter can be seen crossing sacrum to open in left side of bladder.

cases were fused (Cases 1, 6 and 22), and the fourth (Case 3) was an instance of crossed unfused ectopia.

*Associated Congenital Defects.* In five cases (21.7 per cent) there were other congenital abnormalities of the ectopic kidney than those of form and rotation, which are abnormal in most. In Case 21

4A.) In Case 16 the ureter was blind distally, having no relation to the bladder, and was greatly dilated. In one of the kidneys in normal position the pelvis was bifid and in one there was partial renal duplication. In another there was malrotation. (Fig: 4B.) In Cases 12 and 16 there were associated congenital abnormalities of the genital organs. In Cases 3, 6 and 16 there were other, distant, congenital defects.

In three cases (1, 6 and 22) (13.0 per cent) the adrenal gland was recorded as being absent, on the side of the ectopia. These were all cases of crossed-fused renal ectopia.

The renal blood supply of each case was different, being derived from the vessels of the region occupied by the kidney. The numbers of arteries and veins were variable and they entered all parts of the kidneys. The renal pelvis in most cases was extrarenal, especially in the pelvic kidneys. Daseler and Anson<sup>10</sup> (1943) and Anson, Pick, and Cauldwell<sup>7</sup> (1942) have given excellent anatomical descriptions of ectopic kidneys.

*Disease.* In addition to the two cases of hydronephrosis resulting from congenital abnormalities of the ureters, there was one instance (Case 7) of bilateral hydronephrosis, with pain in the ectopic kidney. In three cases there was probable pyelonephritis; in two of these patients most of the pain was in the kidney in normal position. In only one case (Case 10) was

TABLE II  
AGE DISTRIBUTION OF PATIENTS WITH RENAL ECTOPIA

Age in years.....	< 1	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89
No. of patients.....	2	2	1	6	3	3	2	3	1	1

the ectopic kidney pelvis was bifid and in Case 4, the patient with bilateral renal ectopia, one of the pelves was bifid. In Case 14 there was partial duplication of the ureter. In Case 13 the ureter opened into the posterior urethra and there was extreme ureterectasis and pyelectasis. (Fig.

there disease of the normal kidney without disease of the ectopic one. This patient had a small calculus impacted in the normal ureter. Three patients (37.5 per cent of the clinical cases) were operated upon and the ectopic kidney removed, all primarily because of pain (Cases 7, 11

and 13). Case 11 was previously reported by Rusche and Bray<sup>11</sup> (1943) as their Case 2. The patient with a solitary pelvic

Thirteen of the patients (56.5 per cent) were females and ten (43.5 per cent) males. Renal ectopia was 13 per cent more



FIG. 4. Retrograde pyelograms of Case 13. A, right pelvic kidney; renal pelvis and ureter blend, being dilated due to ectopic orifice of ureter in posterior urethra; B, malrotation of left kidney.

kidney (Case 12) was subjected to surgical exploration of the pelvic organs because of the pelvic mass and pain. The absence of the vagina could have suggested preliminary urological study.

**Blood Pressure.** Three of the thirteen patients (23 per cent) on whom accurate blood pressure determinations were recorded had hypertension (Cases 3, 10 and 18). This is of doubtful significance.

#### SUMMARY

The anatomy, incidence and etiology of renal ectopia are reviewed.

Twenty-three cases, fifteen autopsy and eight clinical, are reported. These were of the following types: lumbar three (13.0 per cent), iliolumbar four (17.4 per cent), pelvic twelve (52.2 per cent), crossed four (17.4 per cent). Of the latter, three were fused and one unfused. There was one instance each of solitary pelvic kidney and of bilateral renal ectopia.

common in females than in males of the autopsy series (corrected for greater percentage of male autopsies).

The majority of patients seen clinically were young individuals: 62.5 per cent under thirty years of age.

The right and left kidneys were involved with about equal frequency.

In five cases (21.3 per cent) there were other congenital abnormalities of the ectopic kidneys and in four cases there were congenital lesions of the other kidney. Three of these nine lesions were serious.

Pain, usually in the lower part of the abdomen or back, was the chief complaint. Three (37.5 per cent) of the clinical cases of renal ectopia had nephrectomy. However, in the majority of cases, renal ectopia was apparently compatible with comfort and good health.

Urological study should be performed on all patients who have congenital abnormalities of the genital organs.

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THE *indications* for nephrectomy are severe kidney trauma, tuberculosis, tumors, extensive chronic or acute infection with destruction of the kidney, large calculi which cannot be removed successfully without removal of the kidney, certain cases of ectopic kidney, and selected cases of hydronephrosis.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# HEMORRHOIDECTOMY BY INCISION AND DISSECTION

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IN 1926, Pennington reported favorable results with a type of hemorrhoidectomy which was different from the commonly used methods. The operation described below is an elaboration and modification of Pennington's procedure. The author has performed it one hundred twenty times at the Station Hospital to which he is attached, and has found it more satisfactory than any other operation previously used by him, including the Buie type. The essential difference between this type of operation and the usual hemorrhoidectomy is that it consists of an incision and dissection of the hemorrhoidal tumor rather than an excision of the tumor and its covering *en masse*.

## TECHNIC OF INCISION—DISSECTION OPERATION

The operation is performed under spinal or parasacral anesthesia. The operating table is "broken" and the patient lies on his abdomen in the flexed position. Adhesive straps, anchored to the sides of the table, are used to hold the buttocks apart. With satisfactory anesthesia, the anal sphincter is completely relaxed, allowing adequate exposure of the entire anal canal and any additional pathological conditions such as fissures, hypertrophied papillae, infected crypts or fistulas, are easily visualized.

The skin at the periphery of each hemorrhoidal mass is grasped with Allis forceps and the internal or mucosal extremity of the mass is held up by means of Kocher forceps. The covering of the hemorrhoid between the two clamps is thus held taut and is then incised deeply, after which the edges of the incision are caught with Allis clamps. Treating each half of the incision separately, the Allis

clamp attached to the edge is grasped by the thumb on top and the third, fourth and fifth fingers underneath, while the index finger curls around to exert vis a tergo pressure on the external surface of the flap, thus making prominent the deep surface. In other words, the flap is everted or evaginated, with the deep surface now exposed and stretched across the tip and/or ball of the index finger. The actual hemorrhoidal plexuses, thus visualized, are removed with curved scissors by pressing the convex surface of the opened blades against the bulge and cutting the tissue which is thereby forced into the space between the blades. The assistant can be of great help, when necessary, by grasping a clump of hemorrhoidal tissue with toothless thumb forceps so that it can be snipped away more easily. The other half of the incision is next dissected in a similar manner. Bleeding points, especially minute arterioles, are clamped and tied with fine cotton. Venous bleeding usually ceases spontaneously.

In most cases a considerable amount of redundancy of the flaps is left, and this excess is trimmed away in the following manner: The Allis and Kocher clamps at the extremities of the wound are replaced by straight, pointed hemostats, by means of which the incision is held taut and straight. The flaps are approximated by the Allis clamps previously attached to their edges. An Ochsner clamp is then placed beneath the other clamps, the jaws paralleling the edges of the wound, and raised or lowered according to the amount of tissue to be removed. One may remove more from one flap than the other, as conditions indicate, by applying the crushing clamp accordingly, and, likewise, the amount of mucous membrane to be

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removed may be limited by angulating the clamp. When the Ochsner clamp is locked, the redundancy is removed by

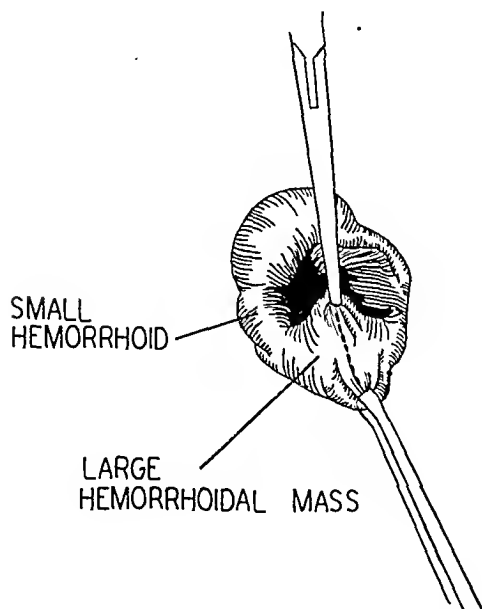


FIG. 1. Attachment of clamps and line of incision over large hemorrhoidal mass.

running a knife closely along the blades. On removing the clamp, the edges of the wound are found to be clean and straight. Any further bleeding which occurs as a result of this last step is treated by individual ligation of bleeding points.

Other discrete hemorrhoidal masses present are removed by separate incisions. In leaving one hemorrhoid to attack another, a change of position of the operator is frequently necessary, but can be avoided if one is ambidextrous. The dissection and undermining of the flaps can be carried out for a distance of one-half of an inch from the edge, so that smaller hemorrhoidal masses contiguous with or adjacent to a larger one can be dissected through the one incision. No intrarectal pack is used for the reason that both its insertion and removal elevate the edges of the otherwise flattened out flaps and thus predispose to postoperative "tags." A vaselined strip of gauze is placed over the wound area and a pressure dressing of gauze and cotton-waste is applied and held firmly by adhesive tape.

Postoperatively, the patient is allowed out of bed after twenty-four to forty-eight hours, at which time Sitz baths are begun. After the sixth day, he is permitted to go to the Mess Hall for his meals and to participate in all the phases of the Hospital Convalescent Training Program, which consists of calisthenics, lectures and craft-work. At the end of two weeks, he returns to duty, with an excuse from hikes and heavy calisthenics for a week, if deemed advisable.

#### RATIONALE OF PROCEDURE

A hemorrhoid may be considered to be a small tumor mass, the covering of which is skin, mucous membrane and the subcutaneous and submucous tissue. As in the case of a small benign tumor elsewhere, such as a lipoma or a sebaceous cyst, it would appear to be better surgery to enucleate or remove the mass by incision and dissection than to resect the entire tumor and its covering *en masse*. This eliminates the use of sutures, and avoids the removal of an excessive amount of mucous membrane or skin.

#### ADVANTAGES OF PROCEDURE

*Simplicity of Technic.* The operation is not difficult to perform. The author, who is a general surgeon, believes that anyone with surgical experience can soon become adept at the technic. The only maneuver which requires some dexterity is the eversion or evagination of the flap by vis a tergo pressure. The tendency of the novice is to pull on the Allis clamp attached to the edge of the flap rather than push with the index finger.

*Absence of Complications and Sequelae.* The amount of skin and mucous membrane removed in this procedure is reduced to a minimum, thus eliminating the danger of postoperative stricture. In fact, in cases in which large hemorrhoids involve virtually all of the circumference of the anus and in which a modified Whitehead operation would be necessary, a complete "cleaning out" of all hemorrhoidal tissue

can be accomplished by several incisions, and yet no more mucous membrane or skin need be resected than is found

postoperative pain they endured, and not without justification. The most startling feature of the postoperative course of

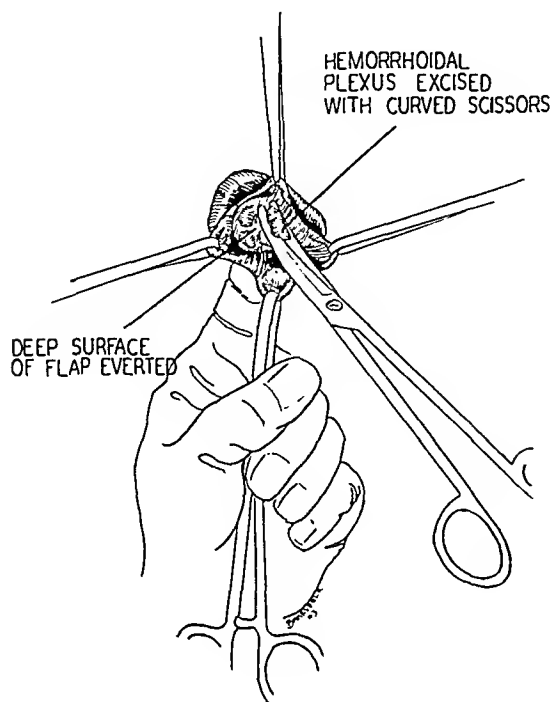


FIG. 2. Excision of hemorrhoidal plexuses from deep surface of one of the flaps, after eversion by means of the index finger. By further eversion, the plexuses in the smaller hemorrhoid shown in Figure 1 can be visualized and excised.

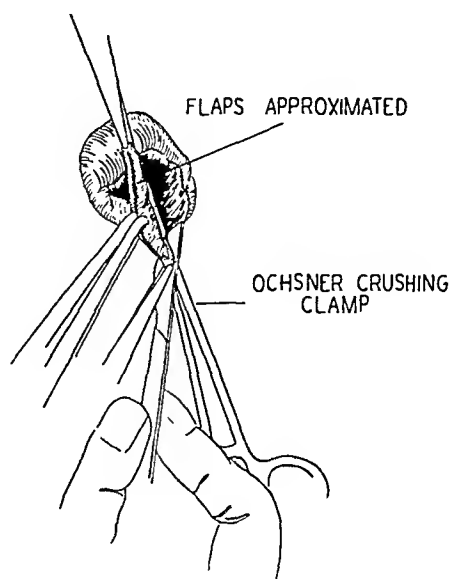


FIG. 3. Removal of redundant skin and mucous membrane.

desirable. Where one attempts to remove two or three "groups" by *en masse* excision, frequently there remain untouched one or more smaller hemorrhoids which intervened between the larger groups. These later increase in size and are frequently the cause of "recurrence." By incision—dissection technic—all masses, regardless of how small they are, can be visualized and excised.

Because no sutures are used and all wounds are left entirely open, adequate external drainage is present and the occurrence of postoperative infection is reduced to a minimum. In this series, no abscesses or deep seated suppurative cellulitis developed.

*Diminution of Postoperative Pain and Convalescent Period.* Most hemorrhoidectomy patients have been known to complain and elaborate on the amount of

the patients operated in this series was the minimal amount of pain and discomfort. An analysis shows that roughly

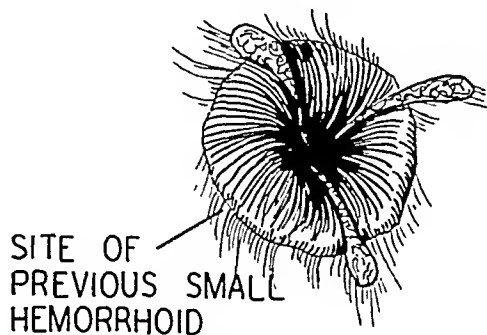


FIG. 4. End result after removal of all hemorrhoidal tissue by three incisions and dissection of adjacent flaps.

70 per cent required no postoperative hypodermic injection of morphine, 25 per cent required one injection, and 5 per cent

required two injections. This is in great contrast to the author's previous experience. Likewise, the first bowel movement did not produce the usual excruciating pain. Patients who had previously been operated upon by another method stated that they had infinitely less pain at the second operation. The most plausible explanation for the diminution of pain is the fact that there are no sutures in the sphincter muscle or elsewhere.

The ability of the patient to return to light activity on the sixth day and to almost full duty on the fifteenth day is of obvious advantage, both in the Army and in civilian life.

*Cosmetic Result.* If the redundant skin is properly trimmed as described above,

and if the use of the intrarectal pack is eliminated, external "tags," which can be a source of distress to the patient, are avoided.

#### SUMMARY

1. An incision-dissection type of hemorrhoidectomy is described.
2. Experience in one hundred twenty cases shows the operation produces far less pain than other types of hemorrhoidectomy, and allows an early return to full activity.
3. The operation reduces the incidence of postoperative stricture.
4. The operation allows adequate removal of all hemorrhoidal tissue, thus reducing the possibilities of recurrence.



MALIGNANT teratoma consists of heterologous elements in which the three germ layers may be very unequally represented. It may be congenital, develop in infancy but usually appears between twenty and thirty years of age. The growth is variegated, contains cystic areas and in the early state is encapsulated. Seminomas are rare in childhood. Teratomas usually grow more rapidly.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# PILONIDAL CYST

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IN the eradication of pilonidal cyst, the multiplicity of advocated treatments indicates that no generally satisfactory procedure has yet been found. The procedure we have followed in 168 consecutive cases, covered from October 1, 1942, to January 30, 1944, is one of marsupialization. From experience gained, we believe that this simple procedure carried out as indicated will return 90 per cent of the patients to duty in approximately twenty-one to twenty-eight days with complete healing of the pilonidal cyst and sinus. The remaining patients will require a longer period of hospitalization because of separation of skin and cyst wall as a result of infection or trauma.

It is not our intention to add confusion to the already perplexing pilonidal question but, rather, we hope to assist in delineating the correct path to be followed in handling this vexing surgical problem.

Warfare imposes conditions of increased activity, excessive perspiration, macerated epithelium, uncleanness for varying periods and trauma in the age group in which symptomatic pilonidal sinus occurs; thus, there has been a virtual flood of these cases to military hospitals. To quote White<sup>1</sup> on his splendid editorial on pilonidal cyst, "Circumstances are more propitious for vanquishing obscure complicating factors in the surgical eradication of pilonidal cyst than at any time in the history of the world."

Eradication of the cyst and sinus by block excision without closure, block excision with primary closure, block excision with pedicle flaps, skin graft, local cyst excision, injection of sclerosing agents and electrocautery are all aimed at either removal or destruction of the cyst wall. These methods have left much to be desired. The procedure to be described

eliminates the sinus and cyst wall by marsupializing them. Epithelization then progresses rapidly from skin edge to skin edge across the marsupialized cyst.

First, acute cellulitis is treated conservatively with cleanliness, rest and hot packs before any surgery is done. The area is then cleansed and shaved as carefully as would be done for any major plastic operation. The usual location of the pilonidal cyst will be seen in Figure 1A. Under spinal or general anesthesia, a grooved director is passed into the cyst, B. The incision is made the length of the sinus down to and through the cyst wall, C. A section of skin one-eighth to one-fourth inch on both sides of the initial incision is removed with a wedge-shaped portion of subcutaneous tissue, along with the outer one-half to two-thirds of the cyst wall, leaving the deep portion of the cyst wall remaining in its bed. (Fig. 1D and E.) This excision permits the skin edges to be brought down to the remaining portion of the cyst wall without tension and without subcutaneous fat bulging between the skin edge and cyst wall. (Fig. 1F and G.) The skin edge and cyst wall are approximated with interrupted No. 40 cotton sutures. The wound is then packed open with a plain, dry, close-meshed gauze pressure dressing.

This dressing is not disturbed for seven or eight days unless cleanliness demands. The sutures are removed on the seventh to tenth day. After the initial dressings, treatments of radiant heat, fifteen minutes twice daily, are valuable in keeping the wound dry and encouraging epithelization.

In the course of operating and observing the postoperative course of these 168 cases, we have learned certain lessons and made observations which we believe will aid



in lowering the incidence of recurrence and in decreasing the period of hospitalization. None of the patients was discharged from

the type of dressing applied and the post-operative care.

The choice of anesthesia is one of the

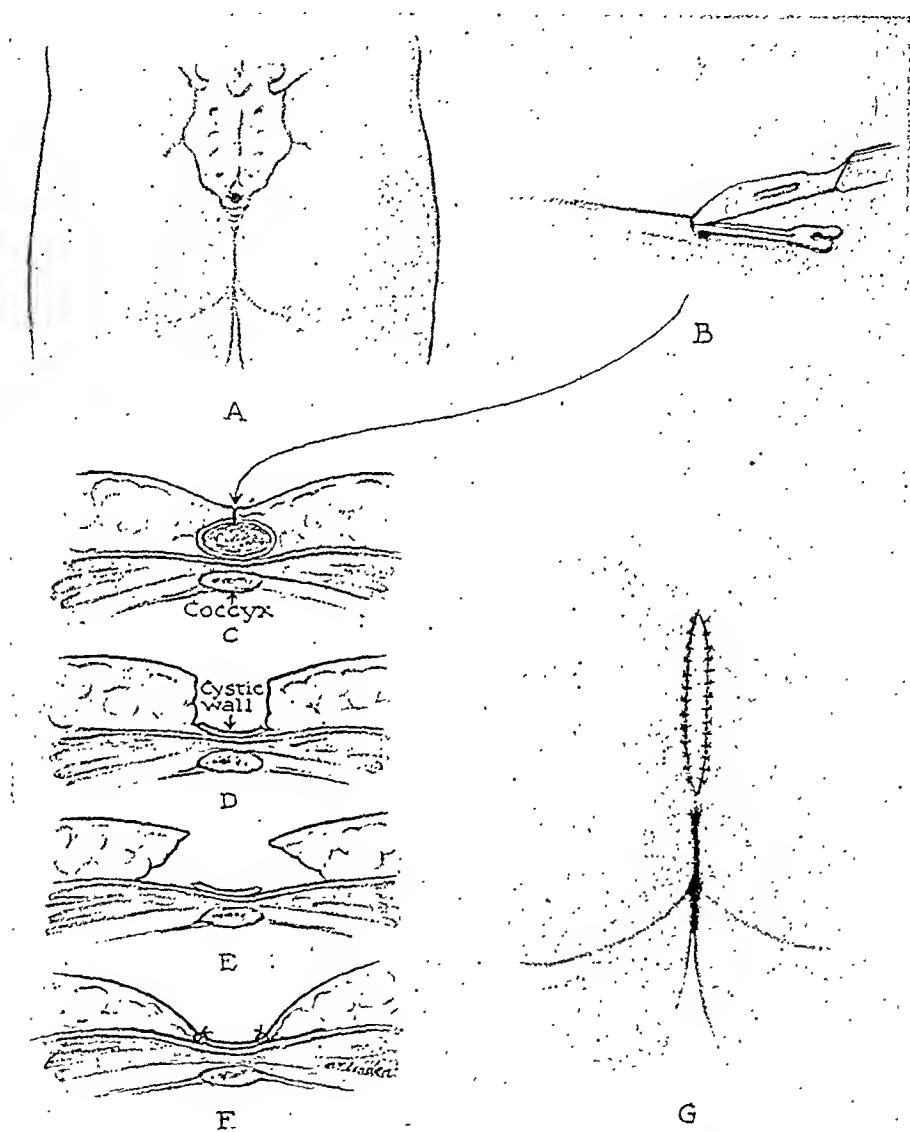


FIG. 1. Drawings showing usual location of cyst with the steps in marsupialization technic.

the hospital unless complete healing had occurred, and the patient was able to return to full military duty. In arriving at our present procedure as described, the patients in the 168 cases reported were operated upon by nine surgeons all using the same general technic except for differences of opinion as to choice of anesthesia, the amount of skin or cyst wall removed,

most important points in the surgical treatment of pilonidal cyst. Reference to Tables I and II is impressive as to the results obtained with local and spinal anesthesia. It is significant to note that the forty-seven patients operated upon under spinal anesthesia had an average hospitalization period of 21.1 days. The 116 patients operated upon under local

anesthesia had an average hospitalization period of 46.8 days. There were no complications or recurrences when spinal anesthesia was used. There were five recurrences and six severe infections following local anesthesia. We no longer use local anesthesia.

The type of dressing is important. It has been found that a close-meshed, plain, dry gauze dressing applied next to the remaining cyst wall and skin with firm pressure is the most satisfactory dressing. Dressings of vaseline gauze or sulfathiazole gauze delay wound healing. The recurrences and infections occurring with local anesthesia are believed to be due to tissue distortion and to the spread-

TABLE I

AVERAGE DAYS IN HOSPITAL OF CASES DONE UNDER SPINAL ANESTHESIA—NOTE DIFFERENCES AS TO TYPE OF CYST AND TYPE OF DRESSING—COMPARE WITH TABLE II SHOWING RESULTS IN PATIENTS OPERATED UPON UNDER LOCAL ANESTHESIA

	No. of Cases	Average Hospital Days
Type of Lesion		
Cyst only.....	5	19
Abscess and sinus.....	9	25.3
Dry sinus and cyst.....	3	24
Draining sinus and cyst.....	30	21.5
Total and Average.....	47	22.1
Type of Dressing		
Sulfathiazole gauze.....	22	29
Sulfathiazole powder and vaseline gauze.....	9	26
Plain gauze pressure dressing.....	16	20.6
Complications.....	0	
Recurrences.....	0	

ing of infection by the needle from contaminated sinus tracts to clean tissues. Under spinal anesthesia, with direct visualization and inspection, no difficulty has been encountered in finding all ramifications. All lateral extensions are followed by the probe and the same surgical treatment of skin and cyst wall applies.

TABLE II

RESULTS OF OPERATIONS DONE UNDER LOCAL ANESTHESIA

	No. of Cases	Average Hospital Days
Type of Lesion		
Cyst only.....	8	51
Abscess and sinus.....	14	59.2
Dry sinus and cyst.....	7	32.5
Draining sinus and cyst.....	87	45.6
Total and Average.....	116	46.8
Type of Dressing		
Sulfathiazole gauze.....	49	66.4
Sulfathiazole powder and vaseline gauze.....	40	52.6
Plain gauze pressure dressing.....	27	31.8
Complications		
Recurrences.....	5	
Severe infections.....	6	

The average age of the patients was twenty-three. Eleven or 6.7 per cent of the patients had had a severe blow to the coccygeal region within the month preceding admission. Twenty-seven or 16.5 per cent were recurrences from surgery elsewhere. Reference to the operative reports shows that the patients who had one-half inch or more of skin removed required an average of 69.1 days for healing, while those with less than one-half inch required an average of 23.8 days.

## CONCLUSIONS

1. This is a plastic operation, and the best results are obtained if the skin and cyst wall incisional defect be not wider than  $2\frac{1}{2}$  cm. to 3 cm. along the course of the cyst or any of its sinus ramifications, because epithelization and cornification progresses slowly if the defect is any wider.
2. Local anesthesia increases the complications, period of hospitalization and the number of recurrences.
3. Dry gauze pressure dressings are best.

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# DICUMAROL IN SURGERY

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MANY articles have recently appeared on various aspects of dicumarol, but none has dealt with all of its important aspects. This paper is written as a review of the subject in an effort to correlate all the facts into a workable thesis. An attempt will be made to present the more plausible viewpoints with a few comments.

Dicumarol is a compound found in spoiled sweet clover and for many years has been known to cause hemorrhagic disease in cattle. Through the untiring efforts of Link<sup>14</sup> and others the product has been synthesized. It has been available for clinical use for several months. However, it still may be considered to be in the experimental stage. When dicumarol is given orally in sufficient quantity, there is a lowering of the prothrombin content of the blood which is detectable by an increased prothrombin time. It is of greatest use in the prophylaxis and treatment of phlebothrombosis and thrombophlebitis.

The mode of action of dicumarol remains highly theoretical. Wakin and Gatch<sup>15</sup> believe that prothrombin is formed in the liver and that dicumarol depresses either its formation or activity. They presented no proof of its interference with liver function. Davidson and McDonald<sup>16</sup> found the drug to act by diminishing the effective prothrombin concentration in the blood. According to Barker<sup>3</sup> the prolonged prothrombin time produced by dicumarol is thought to be due to decreased prothrombin formation.

It is agreed by many<sup>3,6,9,11,12,13</sup> that dicumarol definitely prevents thrombus formation or its extension when the prothrombin time is appreciably elevated. Barker<sup>3</sup> found that thrombosis is rare if

the prothrombin time is above twenty-seven seconds. There is an individual susceptibility to its action<sup>1,8</sup> thus often making it difficult to control the effects produced. Dicumarol should be administered cautiously and only if properly controlled. A prothrombin determination and blood typing should be performed before administering dicumarol. Thereafter a daily prothrombin time must be performed and each dose of dicumarol prescribed separately, having full knowledge of the prothrombin time. Standing orders must not be placed and doses should be given only as specified above. A prothrombin time is without value unless a control is run. The determination loses much of its value unless performed immediately<sup>10</sup> after collecting the specimen because the prothrombin time increases in direct proportion to the amount of time that elapses before performing the determination.

Untoward effects occur but they do not present a major problem nor do they prohibit the use of dicumarol when definitely indicated. Practically the only untoward reaction of any importance found in the literature<sup>2,3</sup> is that of hemorrhage. Hemorrhage may be from the gums, nose, urinary tract, into subcutaneous tissue from slight trauma but more often into the operative wound. According to Lehmann,<sup>9</sup> of Sweden, one case in every ten treated will develop some type of hemorrhage but the complication can be satisfactorily combatted by the use of large doses of vitamin K or fresh whole blood transfusions. Barker<sup>3</sup> reported minor bleeding in 5.3 per cent and major bleeding requiring transfusions in 3.2 per cent of cases receiving dicumarol. Barker,<sup>3</sup> DeBailey<sup>7</sup> and others<sup>16,17</sup> report vitamin K to be

ineffective in lowering the prothrombin time following the administration of dicumarol. On the contrary Davidson and McDonald<sup>6</sup> were able to prevent and reverse the effect of dicumarol upon the prothrombin time by the use of vitamin K. They used a dosage of 250 to 500 mg. of vitamin K in their experiments. The reversal may be rather rapid when vitamin K is given parenterally. Most writers agree that the bleeding tendency can be adequately combatted by fresh whole blood transfusions.

The usually recommended dosage of dicumarol is as follows:<sup>3</sup> 300 mg. by mouth initially, 200 mg. the following day, and 100 mg. each succeeding day that the prothrombin time is below 35 seconds. In the writer's experience this dosage has been excessive. The following is recommended as a safer procedure: original oral dose of 200 mg. followed by 100 mg. the next day and no additional dicumarol until the end of forty-eight hours. Often no appreciable change in prothrombin time is noted until forty-eight or seventy-two hours have elapsed. It is obvious that trouble may ensue if the drug is given in large doses before it is possible to determine the susceptibility of the individual. There is an increased danger of hemorrhage if dicumarol is given earlier than sixty hours postoperatively and preferably seventy-two hours should elapse before it is administered. The desired prothrombin time is the range between 60 and 30 per cent of normal. The bleeding tendency increases rapidly as the prothrombin time approaches or exceeds 20 per cent of the normal.

There is a minority group of surgeons who more or less condemn the use of dicumarol, especially as a prophylactic measure. DeBailey and Zava<sup>7</sup> doubt the merits of dicumarol on the basis that the mode of action is unknown and likewise that there is not complete agreement as to why thrombo-embolization takes place. They believe furthermore that thrombo-embolization is a rare postoperative com-

plication when other well known prophylactic measures are instituted. Zava<sup>7</sup> reported six thousand postoperative pelvic cases without a single incidence of embolism. According to them, the toxic effects and the danger of hemorrhage are too great to warrant the use of dicumarol as a prophylactic measure.

The prophylactic use of dicumarol is gaining in popularity. No one has recommended that it be used instead of the time proven measures in the prevention of thrombo-embolization but rather as an adjunct. It is obvious that it should not be used in every major postoperative surgical patient; neither should it be used indiscriminately. Barker<sup>2</sup> has given dicumarol to a large number of surgical patients during the immediate postoperative period. He gave it to patients who were more or less predisposed to thrombo-embolization because of having had the complication previously or who had undergone operations which are known to predispose to the above mentioned syndrome. There was another group which was given dicumarol prophylactically because of operations associated with obesity, varicose veins, anemia, heart disease, and trauma to large veins during surgery. There was a remarkably low incidence of thrombo-embolization or recurrence of thrombo-embolization in Barker's series. Dicumarol seems to be particularly indicated following extensive pelvic surgery, following cesarean sections, in peripheral vascular disease<sup>1</sup> and crushing injuries of the extremities.<sup>4</sup>

Most encouraging reports<sup>13,16</sup> have been published on the use of dicumarol in the treatment of phlebothrombosis, thrombophlebitis, and subsequent embolization. According to most writers there is no change in the thrombus already present but rather no extension of the thrombotic process. Shapiro and Sherwin<sup>13</sup> found there was a definite decrease in the convalescent period and that the thrombophlebotic patient was more comfortable. Lehmann<sup>9</sup> reported a recovery period of one to three

weeks in patients with thrombophlebitis who received dicumarol as compared to a recovery period of five to eight weeks when the anticoagulant was not administered. All who have used dicumarol extensively as a therapeutic measure agree that it shortens the period of convalescence in the presence of thrombophlebitis.

There is some disagreement as to the contraindications to the use of dicumarol. A better explanation would be that there are very few absolute contraindications and that most contraindications are relative. A bleeding or hemorrhagic tendency and impaired liver function with definite prothrombin deficiency should probably be listed as absolute contraindications to its use. However, seldom would the necessity arise for its use in the presence of the above named conditions. Barker<sup>3</sup> listed these relative contraindications: "1. Ulcerative lesions as open wounds with potential bleeding tendency. 2. Necessity for secondary operations in two weeks. 3. Vomiting due to intestinal obstruction or use of continuous suction. 4. Operation on brain or spinal cord."

#### SUMMARY AND CONCLUSIONS

A brief review of the literature, with some additional comments, has been presented. There are relatively few skeptics and admittedly they have not used dicumarol extensively. According to those who have used the drug extensively it is a valuable prophylactic and therapeutic measure in thrombo-embolization. The untoward reactions presented were not severe enough to prohibit its use. The bleeding tendency which occurred in a small percentage of cases can be adequately combatted by large doses of vitamin K and unquestionably by fresh whole blood transfusions. Apparently there is no contraindication to its prolonged use. The writer has used it almost continuously in one case for six months without untoward reactions. It should again be stressed that dicumarol must be given cautiously and be ade-

quately controlled by frequent prothrombin determinations.

There is a decided decrease in the convalescent period of thrombo-embolization when dicumarol is adequately administered. It is believed that there is likewise a decided decrease in the incidence of postoperative thrombo-embolization when dicumarol is prescribed as a prophylactic precaution. It is of special prophylactic value during the postoperative course of patients who have undergone pelvic operations, especially cesarean sections or in other cases in which there is any reason to fear occurrence of thrombo-embolization. The beneficial effects are not well understood, but the writer predicts that the lowering of prothrombin time is not the only beneficial effect. This prediction is made on the basis that often the septic fever and general malaise in an individual with thrombophlebitis will subside in forty-eight to seventy-two hours.

The writer believes that dicumarol will deservedly win an enviable place in our armamentarium. It is not presented as a substitute form of therapy but as a valuable adjunct to other therapeutic measures.

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MANY conservative operations on the blood vessels have been marred by functional failure, a physiological fault rather than an operative imperfection. This is due to thrombus formation occurring on the damaged intima and spreading peripherally to affect the collateral vessels.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# EPIGASTRIC HERNIA

## AN IMPROVED METHOD OF REPAIR

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THE repair of midline hernia has received comparatively little attention, probably because of the relative infrequency of this lesion. Epigastric hernia occurs in approximately .08 per cent to 4.6 per cent of all hernias in different series. However, various reports have shown that the incidence of recurrence in epigastric hernia is high, ranging from 3 to 14.2 per cent. In the series of Glenn and McBride, the highest incidence of recurrence in primary hernias is in the epigastric type.

When one considers that epigastric hernias are in the upper abdomen and that this portion of the abdominal wall is more prone to wound disruption and post-operative herniation, the aforementioned statistics would not be unusual. The reasons for this are: (1) the greater effect of respiration on the upper abdomen, and (2) the presence of solid fixed viscera there in contradistinction to the lower abdomen.

There are two types of repair generally used for epigastric hernia: The first is that method wherein the linea alba is split above and below the hernial ring opening into it. The protrusion of preperitoneal fat or the true sac is then dealt with accordingly. The two leaves of the linea alba are then merely approximated vertically with a simple or an imbricating suture.

In the alternate type of repair, after the linea alba is split above and below the ring and the sac or fatty herniation ligated, the rectus sheaths on either side are opened and the repair is done in layers. Ordinarily, the incision into the sheaths is made anteriorly and medially at a point where the sheaths fuse to form the linea alba. (Fig. 2.) In this standard type of repair,

when the rectus muscles are exposed by incising along the anterior layer of the sheaths, bilaterally, the posterior layer of the repair would include the linea alba. (Fig. 3A.) In the upper abdomen, the linea alba is not just a linear marking of the fusion of the sheaths as it is in the lower abdomen. Above the umbilicus, the linea is from  $\frac{1}{2}$  to  $\frac{3}{4}$  of an inch in width. In the layered repair when the linea alba goes with the posterior sheaths by virtue of the type of incision made in exposing the rectus muscles, it makes for an easy approximation of the posterior layer of the repair. In the next layer, the muscles are then sutured together in the midline. The third layer is the approximation of the anterior sheath. In doing this type of repair, it has been observed in every instance that this anterior layer approximates with difficulty and under considerable tension, even in the most relaxed abdominal wall. The reason for this is, that when the rectus sheaths are incised anteriorly, it immediately gives the benefit of the extra width ( $\frac{1}{2}$  to  $\frac{3}{4}$  of an inch) of the widened linea alba to the repair of the posterior layer at the expense of the anterior. This can readily be seen in the illustration. (Fig. 3A.)

In order to obviate this, a new technic has been devised in which the amount of tissue both anterior and posterior will be equalized, thus taking the strain off the anterior row of sutures in the repair. This is done in the following manner: The skin and the subcutaneous tissue are incised vertically over the hernial protrusion, exposing the mass with the linea alba above and below. (Fig. 2 in cross section.) The medial margins of the rectus sheaths are also identified. The linea alba is split above

and below the protrusion for about 2 cm. If the hernia is just a properitoneal fatty protrusion, it is simply ligated with its

and transversalis fascia are included in the repair of the posterior layer. When there is no sac present, or there is not specific

## Improved Vertical Repair Of Midline Hernias

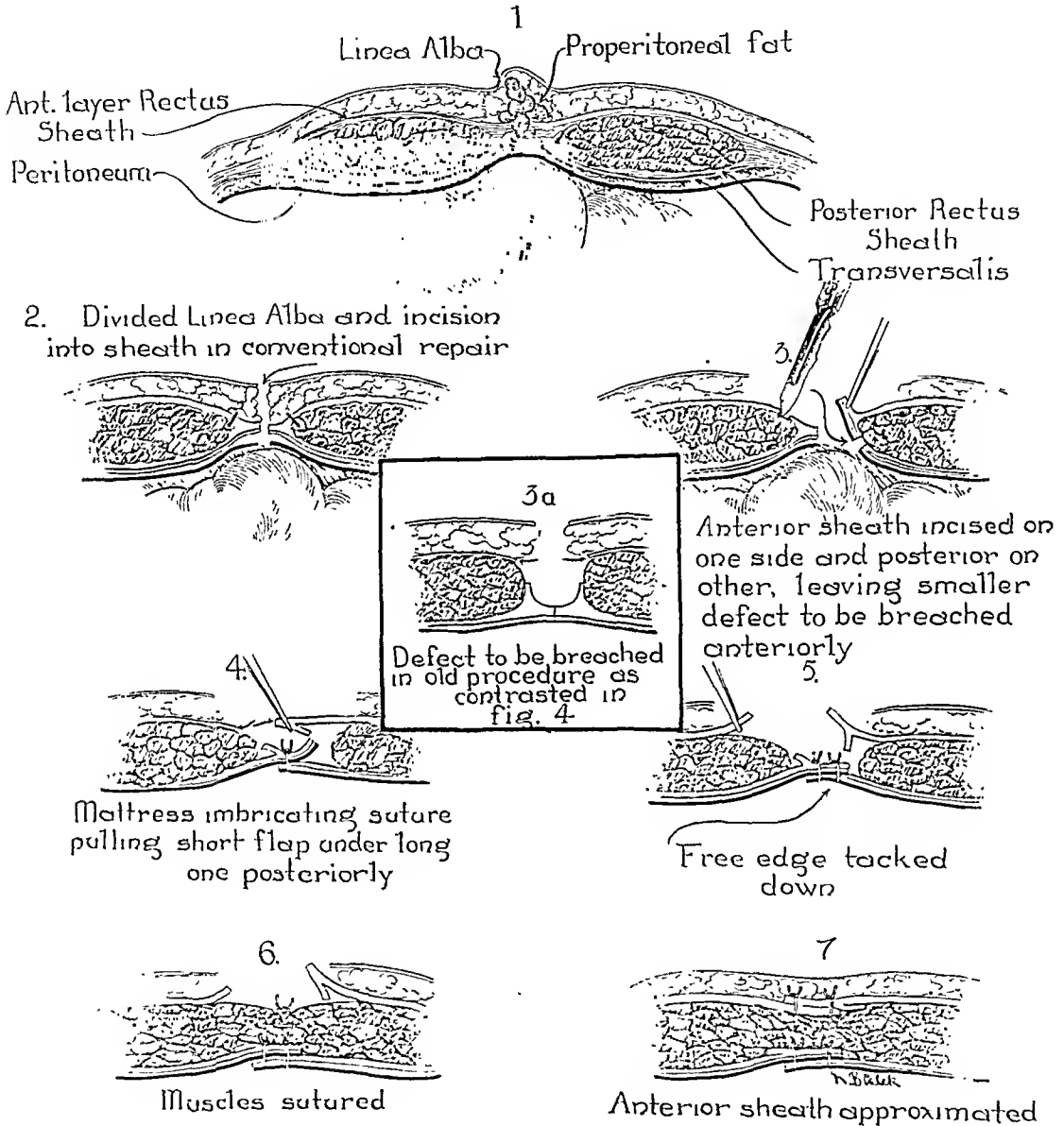


FIG. 1.

accompanying blood vessel. If there is a true sac present, it may be ligated without opening, if the contents have been reduced. When the abdomen has to be explored, of course the sac is opened. When the sac has been opened, the peritoneum

reason for opening the sac, the peritoneum and transversalis fascia are bluntly dissected from the posterior sheath and treated as a separate layer with a purse-string or a continuous suture. The repair is then begun by opening the rectus sheath.



But this is not done in the conventional manner. Instead of opening both sheaths along the anterior margin at the point of fusion, a different step is taken. On one side, the sheath is opened anteriorly at the line of fusion, and on the other, the flap of linea alba is lifted and the sheath is incised posteriorly. (Fig. 3.) This makes for one long and one short flap to be approximated in both the anterior and the posterior layer, with an equal amount of tissue in both. When sutured, the tension on the two layers is the same. (Figs. 4, 5 and 7.) This is in contrast to the conventional type of repair in which both posterior flaps are long and are approximated under no tensions and both anterior flaps are short and are sutured with difficulty.

In the repair, imbricating mattress suture of non-absorbable material is used, such as silk or fine (No. 34) steel wire. (Fig. 5.) The muscles are sutured as the middle layer with a simple suture of the

same material. (Fig. 6.) The skin is closed as desired.

Five epigastric hernias have been repaired in this manner. The technical procedure is simple and obviates any excess tension on the repaired tissues. The incidence of recurrence cannot, as yet, be evaluated.

#### CONCLUSIONS

A new method of repair of epigastric hernias is offered which decreases the technical difficulties and may well improve the high incidence of recurrence of this type of lesion.

Acknowledgement is hereby made of the assistance and advice of Dr. Alfred Ullman, Chief of Surgical Service, Sinai Hospital, in the preparation of this report.

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# TUBE FEEDING\*

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AND

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FOR obvious reasons usually a certain number of hospital patients require alimentation via a rubber tube. They are to be found on medical as well as on surgical wards. Neuropsychiatric patients, for instance, are frequently gavaged because they will not eat. Surgical patients many times receive their food through either a nasal or gastrostomy tube because they otherwise cannot eat.

The fact that the feeding must be fluid in character does not in itself preclude a well balanced dietary. Unfortunately, many tube feedings are not adequate. In devising the one here presented care was taken to see that it meets the criteria of adequacy.

In formulating this feeding we attempted to select easily available items which, when mixed together in proper proportions, yield a readily assimilable diet which is adequate in the essential food substances, vitamins and minerals. The constituents were chosen because of their value and not because of their cheapness which so often is allowed to become the major consideration. Even so the cost of the preparation is a nominal one.

The diet is so constructed that a unit volume (2,300 cc.) yields 2,600 calories, which is slightly more than the daily requirements of a sedentary 70 Kg. man. It is easy, therefore, to assign a relative proportion of the mixture, either more or less as the case may be, to any given individual. For instance, it is simple enough to order the standard formula increased or decreased by a certain percentage, say 10 per cent. This affords the minimum of calculation for the individual who prepares the diet.

The protein fraction has purposefully been increased well beyond the daily re-

quirement of this constituent because the patient who needs tube feeding is almost universally one who has suffered some degree of protein starvation.

The relationship between carbohydrates and fats is in the ratio of 2:1.

The composition of the diet is contained in Table I. The constituents are listed in the left hand column. The weight of each, the measure, and the caloric yield are listed in the next three columns. The number of Gm. of protein and the number of mg. of calcium and iron are next given. The last six columns are used to show the vitamin content of each component. At the foot of the chart the columns are totalled for comparison with the daily requirements of a sedentary 70 Kg. man (as recommended by the Committee on Foods and Nutrition of the National Research Council) which is recorded in the last line.

The allowable substitutions are listed in Table II. The number at the extreme left corresponds with the item of the same number in the preceding chart for which it may be substituted.

The feeding should be prepared each morning and kept under refrigeration until it has been used. Careful corking is necessary to prevent depletion of the contained vitamins.

Since proprietaries are used in this preparation it is appropriate that a statement regarding each be included. Aminoids are used as an adjunct protein source. They are composed of amino acids, dipeptides and prior nitrogenous molecules derived from milk, beef, wheat and yeast. These comprise 45 per cent by weight. Another 44.3 per cent is made up of carbohydrates (dextrose, lactose, maltose and sucrose). It furnishes 102 calories

\* From the Barnard Free Skin and Cancer Hospital, St. Louis, Mo.

per ounce. All of the essential amino acids are present.

Dexin is a very light weight sugar which is composed of dextrins 75 per cent, maltose 24 per cent, mineral ash 0.25 per cent and moisture 0.75 per cent. The advantage of dexin over granulated sugar is the fact that it is largely composed of non-fermentable dextrins which lessens the tendency toward intestinal fermentation with

carded because they are not actually needed and because they are high in avidin which is the antagonist of biotin (vitamin H or coenzyme R) which is contained in the yolk fraction of the egg. We do not know too much about biotin but we do know that such conditions as retarded growth, fatty liver, atrophy of the tongue, weakness, muscle pains, anorexia and a dermatitis are said to develop when this

TABLE I

	Weight		Measure	Cal-ories	Pro-tein Gm.	Calcium Mg.	Iron Mg.	Vit. A I.U.	Thiamin Mg.	Ascor-bie Mg.	Riboflavin Mg.	Vit. D I. U.
	Gm.	Oz.										
1. Milk (whole) ..	1950	...	2 quarts	1350	64.8	1324.	4.76	3770	1.032	40	4246	270
2. Tomato juice....	125	4.4	½ cup	30	1.2	7.5	.75	1065	.115	29	.062	
3. Orange juice ....	122.5	4.3	½ cup	67.5	.75	30.5	.365	275	.134	66	.018	
4. Egg yolks.....	64	2.4	4 yolks	224	9.6	100	5.32	2400	.252	...	.360	
5. Aminoids.....	120	4.0	.....	408	54.0	.....	.....	.....	.....	.....	.....	
6. Dexin .....	120	4.0	24 Tb.	460	.....	.....	.....	.....	.....	.....	.....	1000
7. Drisdol.....	.....	.....	4 drops	.....	.....	.....	.....	.....	.....	.....	.....	
8. Table salt.....	.....	.....	½ ts.	.....	.....	.....	.....	.....	.....	.....	.....	
9. Molasses.....	23	0.8	1 Tb.	65	0.6	59	1.63	.....	.....	.....	.....	
10. Yeast extraet (Vegex).....	7	0.2	1 ts.	10	2.3	4	3.36	.....	.735	...	.630	
Total. ....	.....	.....	.....	2614.5	133.25	1342 mg. or 1.34 Gm	16 mg.	7510	2.2	135	5.3	1270
Requirements for a sedentary 70 Kg. man.....	.....	.....	.....	2500	70	0.8 Gm.	12 mg.	5000	1.5	75	2.2	

TABLE II

5' Soybean flour ....	100	...	1 cup	400	37.3	379	2.7	200-500 micrograms	600-1200 micrograms	600 micrograms
6' Granulated sugar..	104	4.0	8 Tb.	400	.....	.....	.....	.....	.....	.....
7' Cod liver oil.....	9	.3	1 Tb.	99	.....	.....	.....	.....	.....	.....
10' Brewers yeast....	7	.2	1 Tb. or 21 tablets	24	3.5	6.0	1.12	.....	1.050	.490

gas formation. The small proportion of maltose present is readily assimilated before fermentation can occur and the enzymic hydrolysis of the dextrins is sufficiently slow to permit absorption of the dextrose about as fast as it is formed. Dexin is 99 per cent carbohydrate and yields 4 calories per Gm. or about 115 calories per ounce (28.35 Gm.).

Drisdol (brand of crystalline vitamin D from ergosterol) with vitamin A is used as only four drops of it are necessary to furnish one and one-quarter times the minimum daily requirement of vitamin A and two and one-half times the minimum daily requirement of vitamin D.

It will be noted that only the yolks of eggs are used. The egg whites are dis-

substance is absent or present in deficient amounts.

CONCLUSIONS

A recipe is given for a liquid diet which is suitable for passage through a rubber tube before entering a patient's stomach. It is well balanced as regards the carbo-hydrate-fat ratio and the mineral and vitamin content. The protein fraction has purposefully been increased above the daily requirements for this food substance. The diet is easily prepared. Each cc. yields more than one calorie.

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# JOINT ASPIRATION

## A SIMPLE METHOD

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MEDICAL CORPS, ARMY OF THE UNITED STATES

**A**SPIRATION of the knee joint has been looked upon by many physicians and by the laity as a formidable procedure. The physician fears the possibility of introducing an infection into the joint. He believes that the benefits derived from the usual type of aspiration do not compensate for the hazards or the discomfort and pain to the patient. The patient fears aspiration because of the anticipated pain and his impression that joint surgery, even in this form, may result in a stiff part.

Aspiration of a joint can play a very important diagnostic, prognostic, and therapeutic rôle in traumatic joint disorders.

Diagnostically, the presence of a clear serous fluid usually denotes irritation to the synovial lining of the joint cavity. This irritation is produced by direct trauma to the capsule of the joint or severe sprain of the ligaments supporting the joint. A hemorrhagic fluid is the result of laceration within the joint cavity. Fat globules in a hemorrhagic fluid usually indicate a tearing of the fat pad. If the fat globules are large and prove to be bone marrow cells, it is evident that a fracture into the joint has occurred even though this may not be visible in the roentgenogram; for example, a fracture of the tibial spine into the knee joint. Once having arrived at a more accurate diagnosis, one can better determine the prognosis and treatment.

Therapeutically, aspiration of joint fluid relieves tension and discomfort. It also shortens the convalescent period because only a small amount of joint fluid remains to be absorbed by the already injured and edematous synovia. Aspiration of hemorrhagic fluid decreases the tendency toward fibrous adhesions. By decreasing the joint tension circulation is improved and recovery is hastened accordingly.

A simple method of joint aspiration has been used by the author with complete satisfaction. In presenting his technic he makes no claim to originality with respect to the method but presumes it has been utilized by others. The technic involves the use of the following items: (1) An elastic flat rubber bandage roll, measuring three inches wide and three yards long with two twelve inch cotton tapes at one end to act as ties; (2) a No. 17 gauge three inch needle, and (3) a 30 cc. syringe.

The procedure is used most frequently for aspiration of fluids at the knee joint (Fig. 1), but it may also be used for aspiration of fluids from other joints. The technic used in aspiration of the knee joint is as follows: The knee is held in extension. The rubber bandage is wrapped snugly about the joint in the form of a figure-of-eight. It extends about three inches in both directions and is tied about the leg with the cotton tapes. One small area, about the size of a silver dollar, is left uncovered. This area includes the desired point of entry of the needle and is located preferably over the medial aspect of the patella.

The firm elastic pressure distributed equally throughout the entire joint, except the exposed area, compresses the fluid from all sections of the joint cavity toward this exposed area. The fluid pressure forces the medial aspect of the patella upward, away from the medial femoral condyle, and the collection of fluid produces a localized bulging of the capsule. The former allows for a greater area, the latter for an easier site in which to enter the joint cavity.

Once this localized, bulging, fluctuant tumor mass is visible, the examiner will notice an increasing cyanosis of the area. The cyanosis is due directly to the impair-

ment of circulation caused by the tourniquet effect of the elastic bandage. This increasing cyanosis varies directly with an

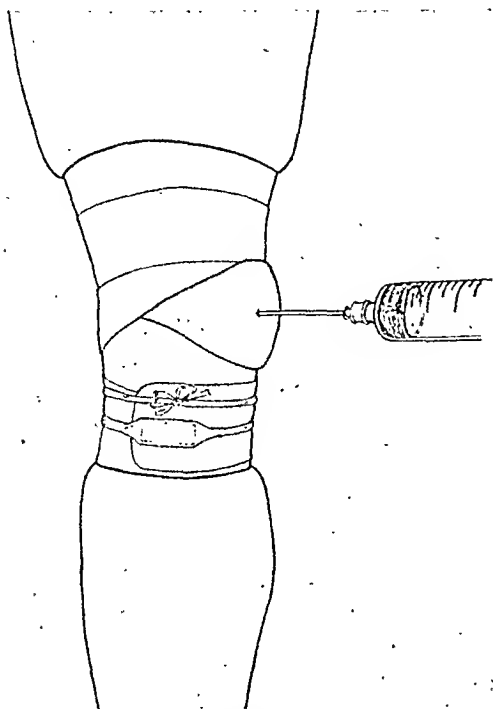


FIG. 1. Rubber bandage applied to a knee joint partially filled with fluid. The elastic pressure forces the joint fluid to one localized area. The impairment of circulation to this area results in complete anesthesia. Elastic pressure forces the fluid into the syringe.

increasing hypesthesia in this area. In fact, sensation becomes so diminished that for practical purposes, a complete anesthesia results in one to two minutes. Not only the skin, but all layers of soft tissue in this area overlying the joint become anesthetized. Because of this anesthesia, the use of a local anesthesia, such as novocain, is unnecessary.

With a pool of fluid concentrated in one small area, the patella lifted away from the medial femoral condyle, and all layers of soft tissue overlying this area completely anesthetized, the operator will encounter no difficulty whatsoever in thrusting a needle into the joint space. The procedure is as simple as entering a vein and does not require any more preparation of the skin than is necessary

for the most simple phlebotomy. The possibility of the needle striking the cartilaginous surfaces of the joint is avoided and thus a painful injury is prevented.

A skin antiseptic is applied over the exposed area. A No. 17 gauge needle attached to a 30 cc. syringe is quickly thrust into the bulging pool of fluid. The insertion of the needle is practically painless and is performed with a single thrust. Once the needle pierces the synovial lining, the tension force caused by the elastic compression results in a rush of fluid into the syringe, slowly raising the plunger. Upon several occasions the author used no syringe and the resulting compression force of the elastic bandage was so great that it caused the fluid to gush as much as ten feet across the room. Once the syringe is partially filled, it is disconnected from the needle and the remainder of the joint fluid is caught in a small basin. The needle is not held. The patient internally rotates the knee so as to take advantage of gravity. As the fluid is removed, the patella may depress onto the bevel of the needle, thus preventing complete aspiration. By rotating the needle about one-quarter turn the obstruction is eliminated. When the fluid ceases to drain, the needle is removed. A dry, sterile dressing is placed over the puncture site and the rubber bandage is removed. An elastic bandage is then applied. The procedure is completed, and the patient is allowed to walk to his bed.

The author has aspirated more than 200 knee joints, in addition to an occasional aspiration of the ankle and elbow joints by this technic without any complications. Even the most frightened patient leaves the table content in the fact that he has been relieved considerably of his symptoms without the slightest degree of pain.

#### CONCLUSION

A simple method for aspiration of joints has been described.

# INVERSION OF THE APPENDICEAL STUMP

## AN IMPROVED METHOD

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On the Staffs of the Grand Forks Deaconess and St. Michael's Hospitals

GRAND FORKS, NORTH DAKOTA

MANY both simple and complicated methods of stitching so as to invert the appendiceal stump after will open into the lumen of the gut). A purse-string suture is placed about the appendiceal base, using No. 000 or No. 0000

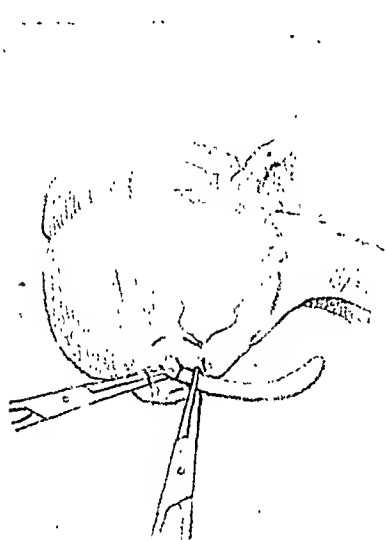


FIG. 1.

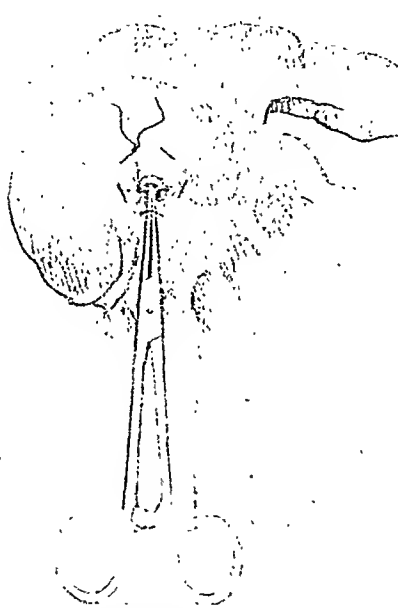


FIG. 2.



FIG. 3.

FIGS. 1 TO 3. Illustrating an improved method of inverting the appendiceal stump.

appendectomy have been described. However, after having tried them all and finding it difficult, at times, to make a nice, clean, complete inversion of the stump, the writer has improved upon the method of Ochsner and Lilly<sup>1</sup> and of Spencer,<sup>2</sup> which are the best so far. I apply a little trick which is a big help in the actual inverting process. The following is a simple and effective technic:

After tying the meso-appendix and cutting it away from the appendix, the site selected for amputation is not crushed. It is just tied off at a distance of about one-third inch from the cecum with a plain No. 0 catgut, using a granny knot (the idea being that a few hours later the knot

chromic on an atraumatic needle and placing the first stitch in such a manner that when the purse-string suture is tied, the appendiceal artery will be included in the tie. Then a Kelly forceps is slipped under a loop of the purse-string suture opposite the ends to be tied and a bite is taken into the appendix just proximal to the constriction made by the tie which tied off the appendix. Now an artery forceps is placed across the appendix just distal to the tie and amputation is consummated between the tie and the distal forceps either with an electrocautery or a knife followed by phenol and alcohol. The purse-string suture is tied by the surgeon while the assistant uses the Kelly forceps,

with its grasp on the stump as described, to complete the inversion. More stitches may be added at the discretion of the surgeon.

This method is simple, time-saving, and absolutely positive.

I wish to express my appreciation to Prof. Paul E. Barr, of the University of North Dakota, who made the drawings.

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AN unnecessary appendectomy should not be done during an abdominal or pelvic operation which probably will be followed by some oozing of blood into the peritoneal cavity. A sump drain is routinely advisable if there is a possibility of postoperative oozing both to indicate the presence and amount of oozing and to keep the cavity free from blood and exudate.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

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# Case Reports

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## TRUE OXYCEPHALY WITH SYNDACTYLISM

### CASE REPORT

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TRUE oxycephaly is an unusual and bizarre deformity of the skull. It is variously known as acrocephaly, dysostosis craniofacialis (Cruzon), and tower or steeple skull. Because of the frequent association of this condition with syndactylism of the four extremities it is also called acrocephalosyndactylia. Its rarity is attested by the fact that in 1938 Valentin<sup>1</sup> was able to collect only eighty-three authentic cases from the world's literature; he added seven of his own.

### CASE REPORT

CASE No. P1727.\* The patient, a twelve year old white male, was first seen at the age of five. He was a spontaneous, term delivery. Deformities of both hands, feet and skull were noted at birth. His early development ran an average course; the first tooth erupted at the age of six months; he sat up unaided at the same age, and he was able to talk at fifteen months. A marked speech impediment was noted at that time. His general health was good. The past medical history was essentially negative with the exception of pertussis.

The family history revealed no similar deformities on either the maternal or paternal branches. Four other children were living and normal in every respect. One granduncle on the maternal side had a supposedly congenital anomaly of the spine, the exact nature of which is unknown. Two distant cousins on the maternal branch, also, had four children blind since birth. There was no other evidence of congenital malformations in the family.

\* Courtesy of Arthur Steindler, M.D., Department of Orthopaedic Surgery, The State University of Iowa Hospitals, Iowa City, Iowa.

The physical examination revealed a well developed and well nourished male of somewhat repulsive appearance. His disposition was friendly and co-operative. He had a marked nasal quality of his speech, which made it difficult to understand him. The Binet I.Q. test was 49, the mental age being six.

The skull was broad in the parietal diameter, and tapered upward in the frontal region. The eyes were widely separated and obliquely set. They bulged prominently. (Fig. 1A.) The ophthalmologic examination showed a convergent squint, postpapillitic atrophy, and defective vision bilaterally. The conjunctiva, especially the palpebral, was hyperemic. Continuous tearing was present.

The patient had a chronic nasal discharge and experienced difficulty breathing through his nose. The septum was very irregular with deviation to the left. The mouth was small ("fish mouth"), and the mandible protruded. (Fig. 1A and C.) The hard palate was very narrow and highly arched, associated with malocclusion. (Fig. 1B.)

The skeletal examination revealed prominence of the acromial end of the clavicle bilaterally. Abduction of the shoulder joints was limited to forty-five degrees; at this point the scapula rotated. He was unable to elevate the arms. There was no limitation of internal or external rotation. Extension of the elbow joints was limited to one hundred seventy degrees. Flexion was free. No restriction of pronation was present, but supination was limited to thirty degrees. The wrist, hip, knee and ankle joints showed no abnormalities.

There was total syndactylism of all five rays of the right hand. On the left the thumb was free, but the remaining fingers were syndactylic. Gigantism of the second and third rays bilaterally was also present. (Fig. 2A.) He was



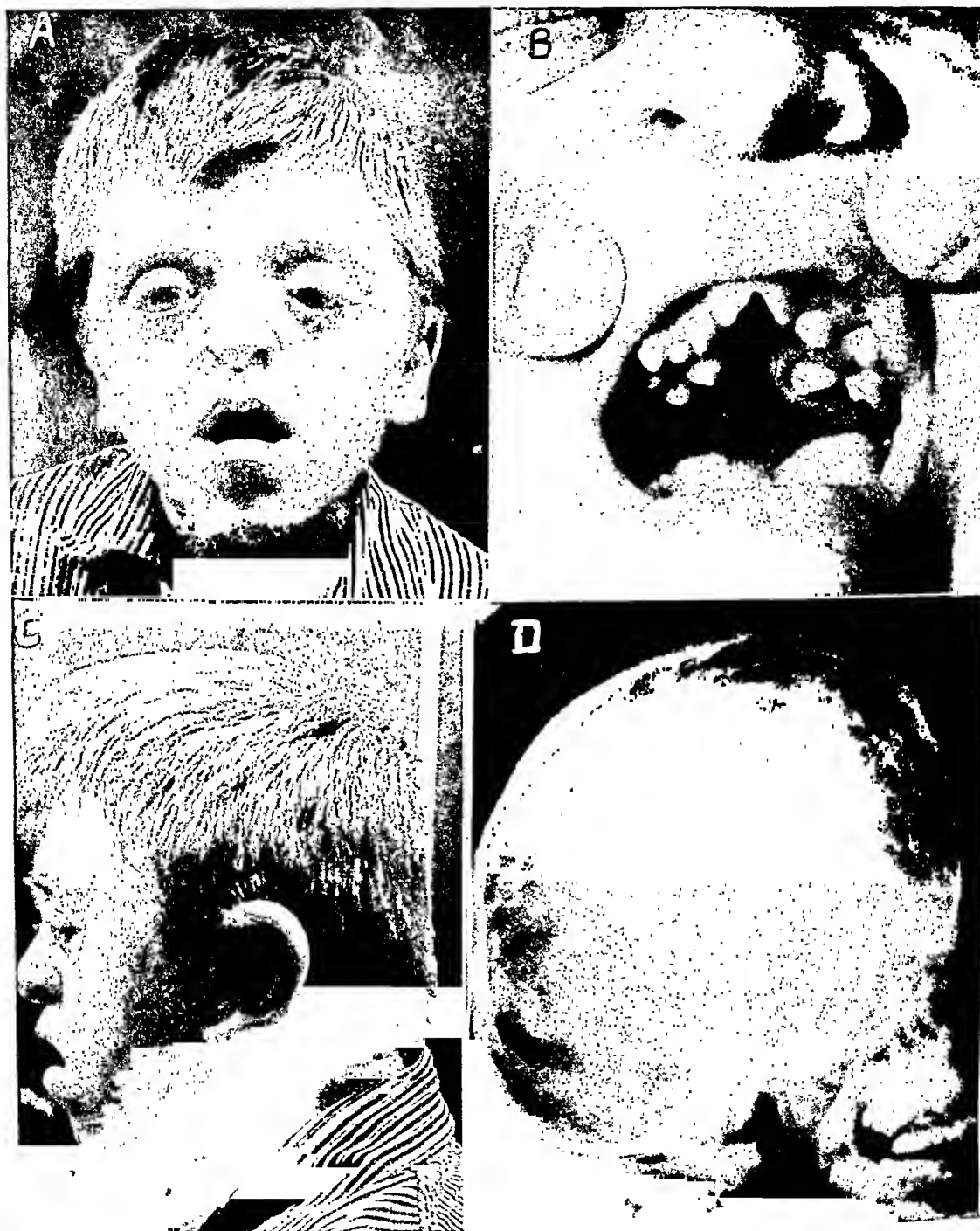


FIG. 1. A, full view of patient. See text for description. B, view of mouth showing very narrow, highly arched hard palate and malocclusion of teeth. C, profile view. D, lateral roentgenographic view of skull.

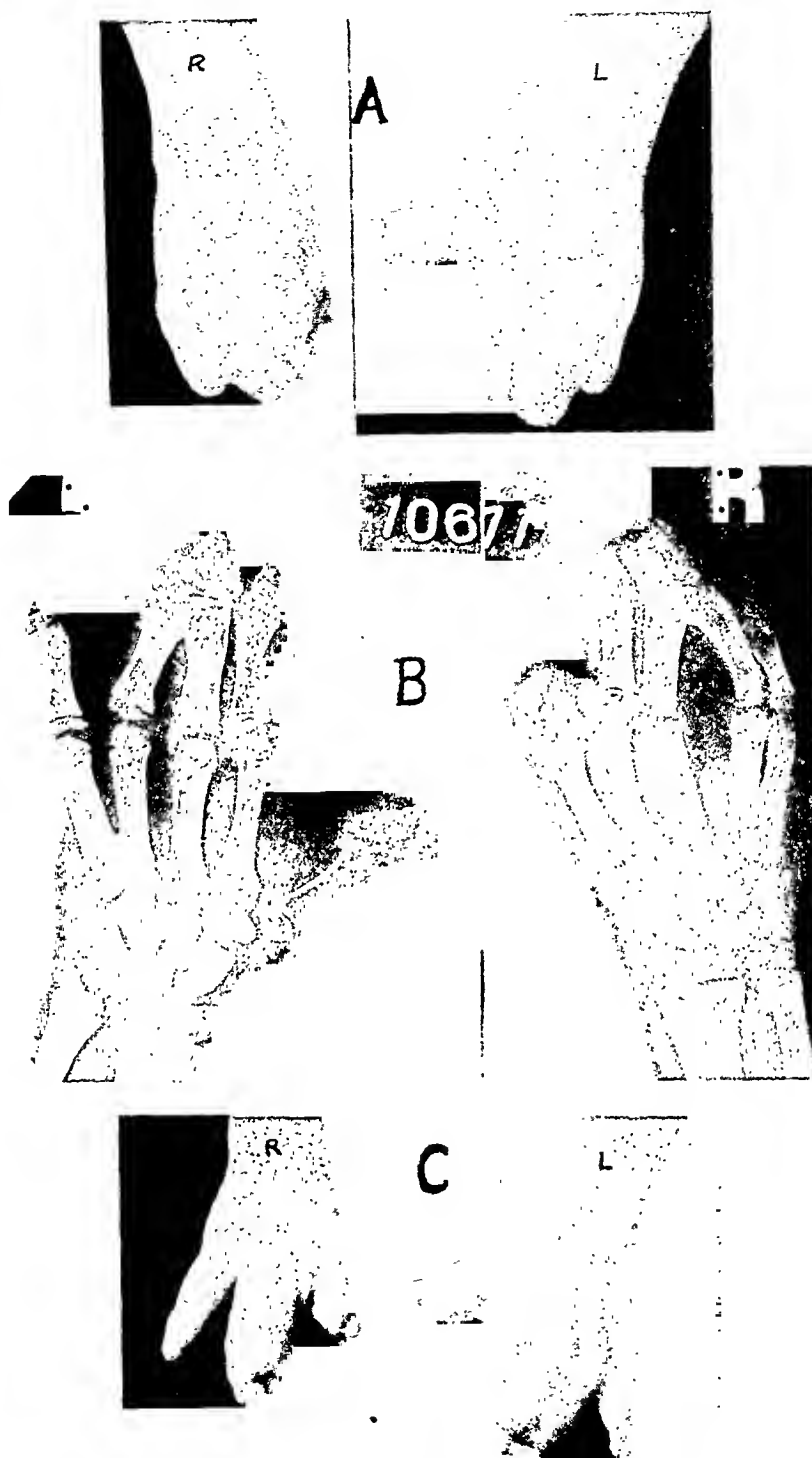


FIG. 2. A, photograph of hands showing syndactylism. B, roentgenogram of both hands. C, appearance of hands after surgical procedures.

able to use his hands quite well for coarse movement. He had somewhat limited motion of the interphalangeal joints.

Both shoulder joints possessed symmetrical malformations. The humeral head appeared flattened with squareness of the lateral margin.

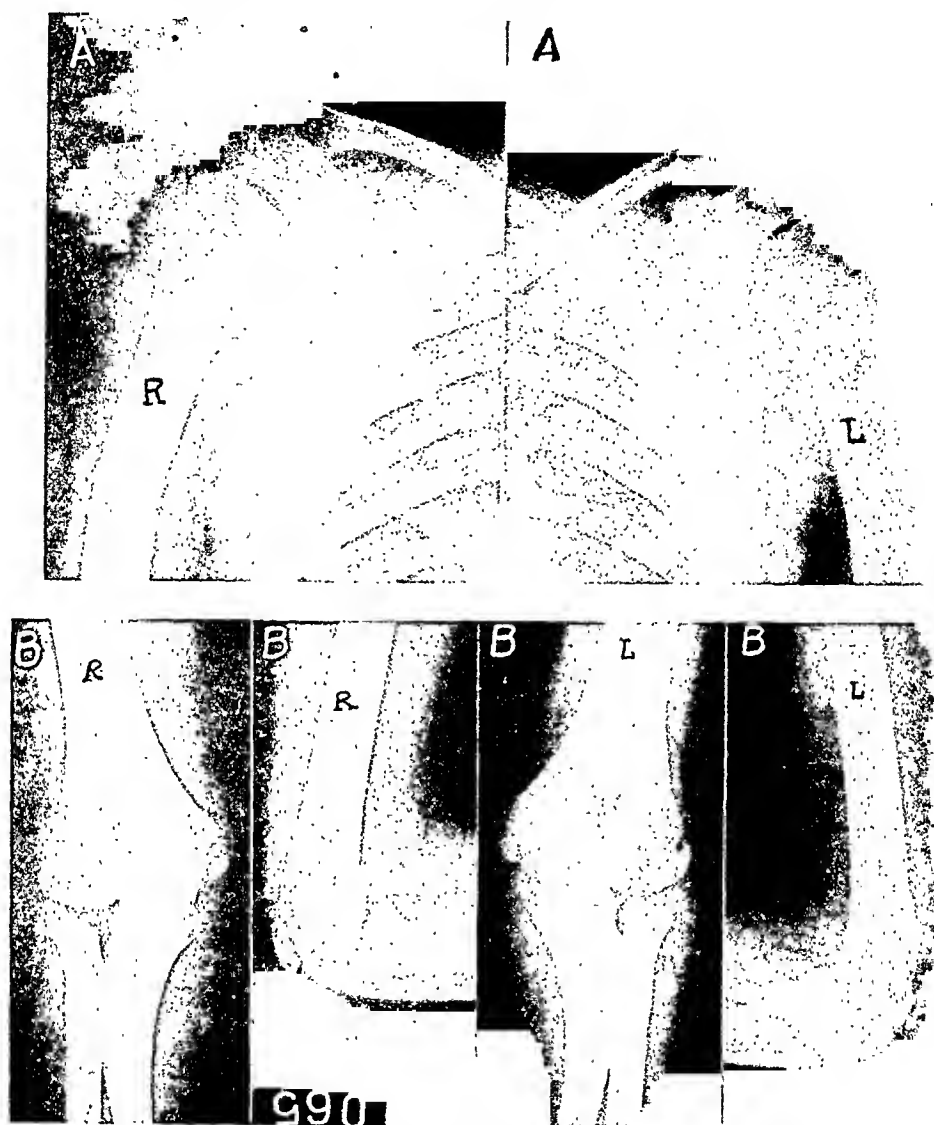


FIG. 3. A, roentgenograms of shoulder joints. B, roentgenograms of elbow joints. Note abnormal curvature of radius and ulna.

The toes were likewise syndaetylic, involving all rays. Besides symmetrical syndaetylicism, gigantism of both first toes was observed. (Fig. 4c.)

Roentgenographically, the lateral view of the skull evinced the typical tower shape. The entire skull had a "beaten silver" appearance. The orbital fossa was very shallow. The sella was markedly enlarged, but showed no evidence of erosion or pathologic changes of the clinoid processes. The prognathism of the mandible was clearly shown. (Fig. 1D.)

The acromial process of the scapula was very large. (Fig. 3A.) Although the elbow joints were essentially normal, there was abnormal bowing of both the radius and ulna which accounted for the limitation of supination noted clinically. (Fig. 3B.)

Synostosis of the proximal portion of the fourth and fifth metacarpals of both hands was present. The fifth finger possessed three phalanges bilaterally. The third and fourth proximal phalanges showed synostosis at the distal ends. This fusion was capped by a large

triangular bony mass which probably represented an attempt at fusion of the mid- and distal phalanges. The index fingers also had

and second metatarsals with gigantism of the first ray was noted. The remaining metatarsals were essentially normal. The first toe consisted

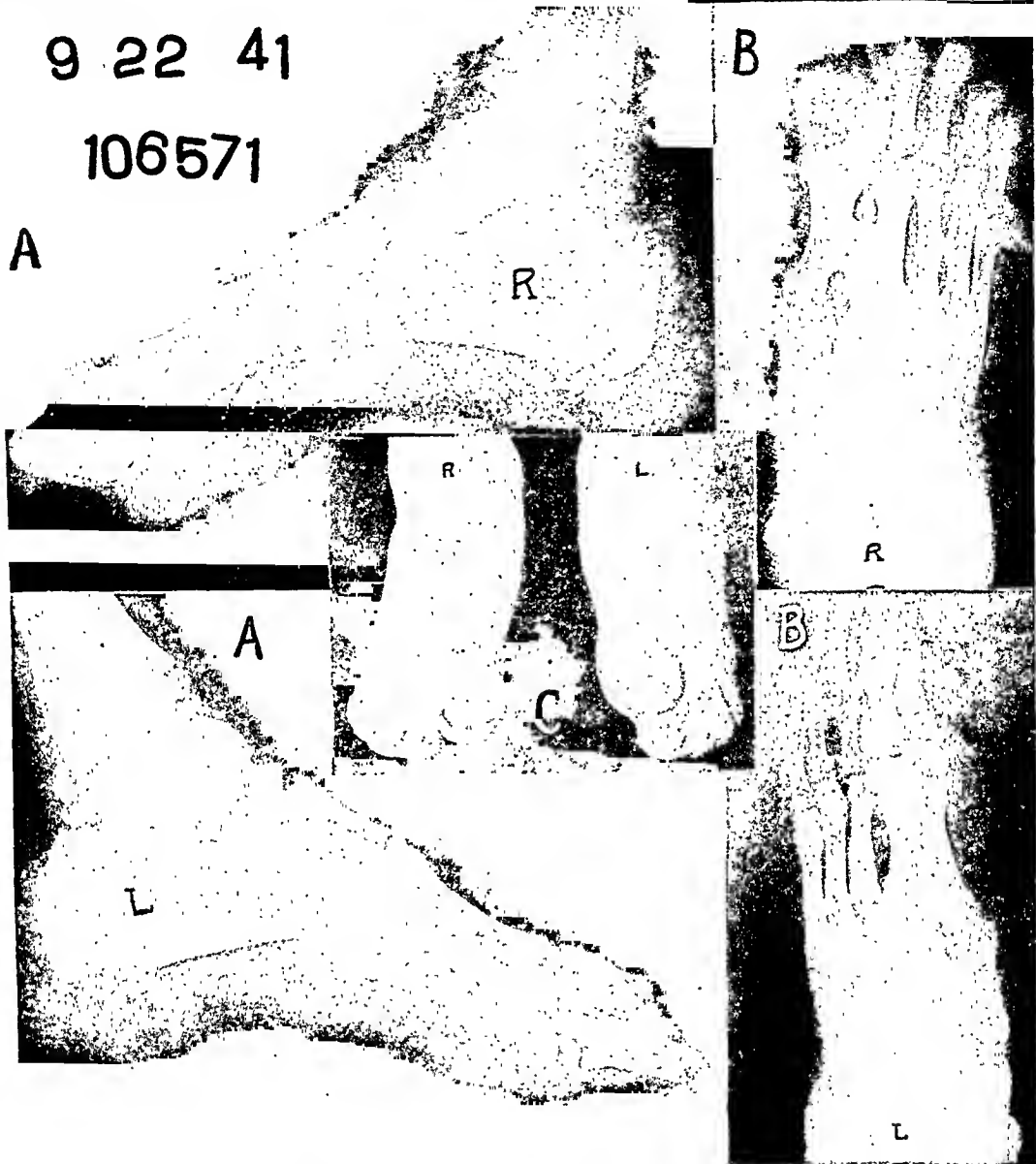


FIG. 4. A, lateral roentgenographic views of both feet. B, anteroposterior roentgenographic views of feet. C, photograph of feet showing syndactylism and gigantism of first toe.

symmetrical deformities; they consisted of but two phalanges. The first metacarpals were essentially normal. The corresponding phalanges, however, were markedly distorted. (Fig. 2B.)

Roentgenograms of the feet revealed similar deformities of the tarsus, metatarsus and phalanges. With the exceptions of the talus and calcaneus the tarsal bones were more or less fused into one mass. Synostosis of the first

of one large triangular mass of bone which appeared to have an epiphyseal line. The remaining toes possessed two phalanges each, a long proximal and a very small distal segment. (Fig. 4A and B.)

The anteroposterior view of the lumbar spine and pelvis showed sacralization of the fifth lumbar segment, associated with spina bifida occulta. Wide diastasis of the symphysis pubis was present.

## COMMENT

The case recorded presents all the essential features of true oxycephaly, namely, the configuration of the skull, the disproportion between the maxilla and mandible, the narrow highly arched palate, the small mouth, and the frequently associated syndactylism of all four extremities. True oxycephaly is not constantly associated with syndactylism, which, when present, may vary in degree and extent. Syndactylism occurs sufficiently often, however, so that the association cannot be entirely fortuitous. The larger joints, as manifested in this case, may also be affected.

Probably because of the bizarre appearance of these individuals, true oxycephaly was known to the ancients. Thersites<sup>2</sup> in the *Iliad* was an oxycephalic. According to Bertolotti,<sup>3</sup> Oribasius was cognizant of this deformity. The oldest clinical description is found in the case of Lycosthenes<sup>4</sup> (1557). Apert<sup>5</sup> (1906) was the first to point out the frequent association of syndactylism with the skull deformity. He coined the term "acrocephalosyndactylia."

The deformity is said to occur as an isolated instance, as in the case reported. Greig<sup>6</sup> states that "several cases of transmission from a parent to one or more of the children have been recorded, but no case of transmission to the third generation has been observed." Valentin,<sup>1</sup> on the other hand, writes "so far the world literature has not presented a single case of pure acrocephalosyndactylism in which heredity or familial occurrence of exactly the same malformation has been described."

The *modus operandi* of the skull malformation is an unexplained disturbance during embryonic life. The sutures become fused, and the rapidity of brain growth during the intrauterine period and early infancy produces the peculiar configuration. The facial bones are also involved by the premature synostosis.

The synostosis of the skull sutures gives rise to the secondary malformations, such as the shallow orbital fossae, the characteristic palate, stenosis of the large foramen

of the skull, especially the optic and jugular, and the convolutional markings of the skull, the so-called "beaten silver" appearance. The latter finding, however, is not pathognomonic of oxycephaly; it may be found in other conditions.

The shallow orbital fossae cause bulging of the eyes. The bulging may become so marked that spontaneous dislocation of the eyeball may occur, as reported by Sherne.<sup>7</sup> Papillo-edema or even optic atrophy, which is a constant late feature, is present. Dyson<sup>8</sup> suggests that these symptoms may be explained upon the basis of kinking or pressure on the optic nerve by the narrowed foramen with consequent venous congestion and atrophy. Neurosurgical procedures have recently been attempted to relieve the failing vision or threatened blindness with some measure of success.<sup>9,10,11</sup>

The mentality is usually affected, as manifested by the mental age of six in the case presented. It is readily appreciated that premature closure of the cranial sutures does not permit the normal growth of the brain to take place.

True oxycephaly must be differentiated from acquired or false oxycephaly, a distinction not frequently made in the literature. The distinguishing clinical characteristics have been emphasized by Greig.<sup>6</sup> In false oxycephaly the synostosis is limited to one or at most only a few of the cranial sutures; the facial bones are never involved; associated deformities are not present, and the base of the skull is not affected. In true oxycephaly the apex of the height of the head is at or near the bregma; in false oxycephaly the head height shows a much greater variation, in many cases being located at the posterior part of the skull.

The syndactylism when extensive or complete, is amenable to surgery. Operative treatment offers not only cosmetic but also functional improvement. The case presented was beneficially aided by Pieri Z plasties, full thickness grafts and resection of the fourth ray and finger. (Fig. 2c.)

Care must be exercised in outlining operative therapy to ascertain, if possible, whether any congenital deficiency of the tendons or intrinsic musculature is present. It is preferable to have web fingers which function as a whole rather than to isolate a finger only to find that the patient is unable to flex it.

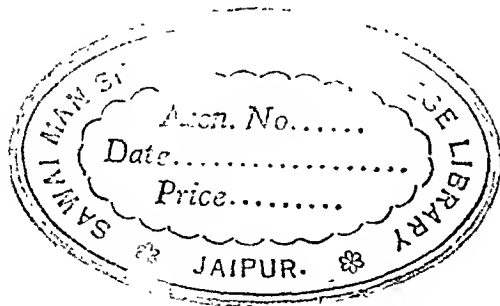
#### SUMMARY

A case of true oxycephaly associated with syndactylism of the four extremities and other malformations is presented. The features of this unusual congenital aberration and the differentiation from false oxycephaly are discussed.

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# AIR EMBOLISM IN OBSTETRICS AND GYNECOLOGY\*

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AIR embolism is a medical catastrophe. As early as 1667 Ride produced death in cattle by blowing air under pressure into their jugular veins. Beauchesne, in 1818, during the removal of a neck tumor observed the first recorded case of air embolism in the human.

There are two types of embolism—the venous and the arterial. In the venous air embolism air enters the peripheral veins and flows by means of the vena cava to the right heart and thence to the pulmonary arteries. In arterial embolism the site of entry is the pulmonary vein whence the air passes from the left ventricle to the systemic circulation and the brain.

There is no agreement as to the amount of air which constitutes a fatal dose. Rabbits will die after the rapid injection of 10 cc. of air into an ear vein. In 1937, Richardson, Coles and Hall, basing their inferences on experimental air embolisms produced in small animals, estimated that about 500 cc. of air would be required to kill a human being. Moreover, there is no constancy in the amount required even in individuals of the same species.

The prerequisites for the development of an air embolus are: (1) a vessel which is in a state of incomplete collapse, either because its wall is only partly opened, or because fascial attachments prevent its retraction, and (2) suction produced by negative venous pressure or else the introduction of air under positive pressure into the circulation.

These conditions are satisfied during many therapeutic procedures. Among the most common are the establishment and maintenance of pneumothorax, pneumonectomy, lobectomy, thyroidectomy, radi-

cal breast amputation, puncture of the paranasal sinuses, fractures of the long bones, continuous intravenous injections, perirenal insufflation, introduction of air into a joint cavity or the bladder; and of more interest to obstetricians, the induction of abortion, manipulation of the pregnant and puerperal uterus and, lastly, tubal insufflation.

The presence of air embolism is recognized by sudden shock, dyspnea, and cyanosis. If air is in the large veins, hissing sounds may be heard and bruits or churning noises are heard over the heart area. If air escapes into the arterial circulation, there is blindness. This is caused by air in the retinal vessels and may readily be seen by the ophthalmoscope. There may also be areas of skin blanching due to interference with the capillary circulation. Death may be instantaneous or may occur within several hours. About 15 to 50 per cent of the cases end fatally. If the patient survives the first fifteen minutes, the prognosis is good; if she survives the first hour, coma and paralysis clear.

There is no uniformity of opinion as to the mode of death. The common theories state that the non-compressible air replaces the compressible blood in the right heart, thus causing cardiac standstill. This alone, or obstruction in the pulmonary bed by air prevents the transfer of oxygenated blood from the right ventricle to the left auricle. Other theories postulate that coronary artery embolism is the cause of death, while others state that the ischemia of the vital brain centers produces the fatal result.

In a case of suspected air embolism it is necessary to ligate the great vessels before

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removing the heart and then to open the heart under water at which time the emboli are released.

A knowledge of the pathological anatomy leads to rational, but often ineffectual therapy. Artificial resuscitation is given, cardiac and respiratory stimulants are administered. Inhalations of 90 to 100 per cent oxygen facilitate the absorption of nitrogen bubbles in the circulation. Aspiration of the right ventricle has been attempted, and in an attempt to replace the frothy mass of air and blood in the right ventricle 50 to 100 cc. of saline solution have been injected.

Air embolism is of especial interest to obstetricians and gynecologists. In 1829, Legallois first suggested that air might enter the circulation by way of the uterine veins. Cormack, in 1850, and May, in 1851, described the first cases of air embolism associated with pregnancy. Air embolism in obstetrics most commonly follows the induction of abortion by means of a syringe. This is especially true when a low-lying placenta provides venous sinuses for the ready introduction of air into the circulation. Placenta previa at term is occasionally associated with air embolism, especially when version is performed. Several patients have expired instantaneously as a central placenta previa was being ruptured to obtain a foot. Several deaths have followed the now outmoded use of an intrauterine douche. In 1938, Osborn and Dawson described two cases of air embolism. In their first patient a classical cesarean section was performed under gas-oxygen-ether anesthesia for cephalopelvic disproportion. There is no mention of the location of the placenta, but at the time of the uterine incision the patient suddenly went into shock and three hours afterwards died. Autopsy revealed air bubbles in the right heart. Their second patient died abruptly. Two hours previously a spontaneous delivery had occurred. The conduct of the third stage is not mentioned. The autopsy revealed air in the right heart and, in addition, a uterus

which was partially inverted with the fundus at the internal os.

Four deaths following tubal insufflation have been reported. The first two of these were recorded in 1927 by Moensch of the New York Post-Graduate Hospital. In the first case, an insufflation was followed by a curettage. Death occurred immediately. At postmortem, air was found in the right heart and the right femoral vein. In the second patient, a negress, sudden death followed a tubal insufflation. Air was found in the right heart, in the peritoneal cavity and, in addition, there was a small perforation of the intestines. Weitzman and Cohen, in 1937, reported a patient who died of multiple cerebral hemorrhages three days after an insufflation. The autopsy also revealed bilateral salpingitis with a dermoid cyst filled with air and adherent to the left tube. The fourth case was recorded by Dible in 1938. An insufflation was performed under open drop ether one day prior to the menses. Though the gas was heard to pass at 150 mm. of mercury, the patient became cyanotic and respirations ceased. For four minutes more the heart was heard to beat irregularly and feebly. The autopsy showed a recent corpus luteum in the ovary. The uterine vein was filled with air bubbles. The inferior vena cava, the right auricle, the right ventricle and the pulmonary artery were filled with frothy air.

Another case of interest was reported by Peirce. Death occurred during the vaginal insufflation for trichomonas in a twenty-six-year old primigravida who was four months pregnant. The autopsy revealed that the membranes were separated from the uterine wall by air which filled the uterine sinuses. The inferior vena cava was also filled with air. Two similar cases are reported by Brown and Partridge of fatal air embolism following vaginal insufflation for trichomonas vaginitis in the last weeks of pregnancy. These authors conclude that the danger of embolism increases as the placenta enlarges and as the cervical os becomes more patulous and,



hence, insufflation is contraindicated in the last months of pregnancy.

#### CASE REPORT

A twenty-eight year old nulliparous colored woman was admitted for tubal insufflation because of sterility of four years' duration. The general physical examination was normal; the pelvic examination revealed a marital outlet with a clean cervix; the uterus which was anterior, was normal in size; and the adnexae could not be outlined. Menses began at twelve years, occurred every twenty-eight days with a two to four day flow. On the twenty-first day of the menstrual cycle the patient was anesthetized with nitrous oxide and ether anesthesia. After the uterine cavity had been sounded at 9 cm. passage of gas at 80 to 100 mm. was heard on two occasions. Curettage was then performed; about  $\frac{1}{2}$  cc. of tissue grossly characteristic of secretory endometrium was obtained. At this time, about twenty minutes after the start of the operation, the anesthetist stated that the patient had difficulty in breathing. Examination revealed that the respirations had ceased and that only a feeble carotid pulse could be obtained. Resuscitation and stimulants were used without avail. Autopsy revealed a patent left tube, a stenosis in the outer third of the right tube about 2 cm. from the fimbriated end, a corpus luteum in the right ovary and 25 cc. of air in the right ventricle and pulmonary arteries. It was thought that either air was introduced at greater pressure than the operator realized, or that the curettage broke down the uterine sinuses and so permitted entry of air into the pulmonary circulation.

Rubin has always maintained that an insufflation should be performed only immediately after the completion of the menstrual period. However, sometimes in an effort to save time a patient is admitted for the simultaneous performance of insufflation and endometrial biopsy in the

late premenstrual period. This is to be condemned for two reasons: (1) The performance of the insufflation at a stage when such great vascularity exists and, (2) the simultaneous curettage which may open up venous sinuses for the entrance of air.

#### CONCLUSIONS

1. A case of fatal air embolism following tubal insufflation is recorded. Four similar cases derived from the literature have been reviewed.

2. Because of the danger of air embolism, tubal insufflation should not be performed in the premenstrual phase, nor should a curettage be done simultaneously.

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# SUPPURATIVE TYPHOID SPINE PERFORATING INTO THE BRONCHUS\*

## CASE REPORT

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WE wish to report an unusual case of suppurative typhoid spine which formed a paravertebral abscess and chief complaints of intermittent lumbago and sciatica of ten years' duration. His symptoms were described as back pain and a pain that



FIG. 1. Postero-anterior x-ray of chest showing an irregular density in the medial portion of the right lung.

perforated into the lung. The length of the latent period, the confusing symptomatology and the efficaciousness of the treatment employed are of sufficient interest to make the case worthy of publication.

## CASE REPORT

W. P., a thirty-four year old colored male, was first seen in the Out-Patient Clinic with the

radiated down the back of his right leg. Physical examination revealed a slight limitation of back motion, a positive Lcsague's sign of sciatica and a diminished right Achille's reflex. The patient's temperature was normal; a blood count showed a slight leukocytosis and a tuberculin patch test was positive. Blood and spinal fluid Wassermanns were negative. The colloidal gold curve of the spinal fluid indicated an inflammatory process. An antero-posterior roentgenogram of the lower lumbar

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vertebrae and pelvis was normal. He was next seen two months later when he was admitted to the hospital.

mobility of the spine, but the curvature of the vertebral column seemed normal. No tumors or tenderness were palpable in the abdomen,



FIG. 2. Anteroposterior x-ray of thoracolumbar vertebrae showing loss of details of bony architecture and osseous proliferation in the involved area.



FIG. 3. Right lateral x-ray of thoracolumbar vertebrae showing irregularities of the intervertebral spaces and wedging of the vertebral bodies.

The patient's interval history was one of increased back pain, fever, cough and lameness of the right leg. The fever and cough increased and soon the patient started to expectorate large amounts of purulent sputum which later became foul. A few days before admission two masses appeared on his back which progressively increased in size. The patient estimated that he had lost about fifty pounds of body weight.

The patient's past history was insignificant except for typhoid fever twenty-two years ago. There was no family history of tuberculosis.

The patient appeared acutely ill and frequently coughed up foul, purulent sputum. His temperature was 102°F. orally, pulse 120, respirations 32 and blood pressure 110/65. The patient disliked being moved during the examination because of the painful back and a complete examination was not done. The head and neck were normal. The percussion note was dull over the right chest posteriorly and many coarse râles and some rhonchi were heard in this region. The left lung and heart were normal. Two fluctuant masses, measuring four by ten inches, straddled the spine at the thoracolumbar junction. There was marked spasm of the back muscles and limitation of

but a soft fluctuant mass was palpated in the right inguinal region. The right leg was maintained in a slight degree of internal rotation and semi-flexion, although it could be extended. The neurological reflexes of the legs were normal except for an absence of the right Achilles's reflex.

The blood count showed a leukocytosis of 12,500 with 87 per cent polymorphonuclear leukocytes. The erythrocyte sedimentation rate was 117 mm. in an hour, the blood calcium and phosphorus were 11.4 and 4.0 mg. per cent, respectively, and the alkaline phosphatase was 2.8 B. units. The urinalysis was essentially negative. Repeated sputum examinations failed to reveal tubercle bacilli. Sputum cultures grew *Streptococci viridans*, *Staphylococci aureus*, colon bacilli and *Neisseria catarrhalis*.

A diagnosis of pulmonary tuberculosis, tuberculosis of the spine and psoas abscess was made on the patient's admission and he was transferred to the isolation ward.

A postero-anterior roentgenogram of the chest was interpreted as showing an irregular density extending from the second rib to the diaphragm in the medial portion of the right lung. In addition the vascular markings at the hilum were increased. The conclusion

was pneumonitis, tuberculosis unlikely, possibly foreign body in the right lower lobe. (Fig. 1.) Anteroposterior and right lateral roentgenograms of the vertebral column showed loss of details of the bony architecture of the lower thoracic and the upper lumbar spine, slight wedging of the vertebral bodies of thoracic eleven and twelve and lumbar one, narrowing of the intervertebral space between thoracic nine and ten and eleven and twelve, with an absence of the intervertebral space between thoracic twelve and lumbar one. The involved intervertebral spaces were hazy and ill defined, while the vertebrae in this region showed bony proliferation. The conclusion was spondylitis and hypertrophic arthritis of the thoracolumbar spine; specific etiology unknown, doubtful of tuberculosis, probably pyogenic. (Figs. 2 and 3.)

Bronchoscopy revealed an inflamed right lower lobe bronchus from which thick, foul, purulent material was aspirated. The specimen was sent to the bacteriology laboratory for examination. No foreign body, tumor or ulceration were seen. Aspiration of both fluctuant masses on the back yielded non-foul purulent material which was sent to the bacteriology laboratory for examination. A few cc. of methylene blue were injected into the abscess space of the left mass and within twenty-four hours the patient's sputum was stained the characteristic blue color.

The bacteriology laboratory reported the colon bacilli in the sputum as *Eberthella typhosa*. The bronchoscopy specimen showed mixed organisms including *Eberthella typhosa*. The specimens aspirated from the fluctuant masses on the patient's back yielded pure cultures of *Eberthella typhosa*. Sero-agglutinations of typhoid antigens O and H were significantly positive, while paratyphoid A and B were negative. All blood, stool and urine cultures were negative for the typhoid bacilli.

The diagnosis of tuberculosis was discarded and instead one of a suppurative typhoid spine with a bronchial fistula and paravertebral and psoas abscesses was made. The pneumonitis was associated with the bronchial fistula, the sciatica with the paravertebral abscess and the lameness of the right leg with the psoas abscess, all originating from the typhoid osteitis of the spine. (Fig. 4.)

The paravertebral abscesses were incised and drained; then dusted with sulfathiazole crystals and packed open with vaseline gauze.

The patient was placed on a Bradford frame and given sulfathiazole orally with marked relief of toxic symptoms, although his blood

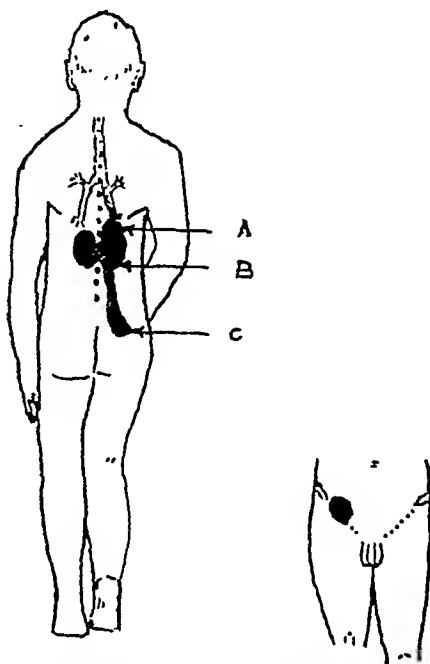


FIG. 4. Diagrammatic sketch which illustrates the regions involved. The typhoid spine abscess (A) perforated into the lung, (B) formed subcutaneous abscesses on the back and (C) extended along the psoas muscle to the groin. The smaller illustration shows the fluctuant mass in the inguinal region.

concentrations were only 2 to 3 mg. per cent. The patient rapidly improved and at the end of his second hospital month he was sent home. At the time of the discharge his wounds were well healed, the fluctuant mass in the right groin had disappeared and there was no pain even with back motion or bending over. The sciatica and lameness were not in evidence and he rarely coughed. Throat cultures were negative for typhoid bacilli, the erythrocyte sedimentation rate was 51 mm. in an hour and the temperature, pulse and respirations were normal.

The patient remained on a modified fracture bed at his home for a month and then was again seen in the Out-Patient Clinic. He had gained twenty pounds, was afebrile and had no back pain. He had no cough, the wounds remained well healed and the right Achilles's reflex had become normal. The erythrocyte sedimentation rate had decreased to 37 mm. in an hour. A metal back supporting brace was ordered allowing the patient to become ambulatory.

During the following four months the patient wore his back supporting brace and was entirely asymptomatic. His erythrocyte sedimentation rate dropped to 22 mm. in an hour and he gained an additional twenty-five pounds of body weight. Roentgenograms of the chest and spine showed some improvement, but not in proportion to his clinical course.

The patient has now been followed for two years with progressive improvement of his health. He has gained seventy pounds and his erythrocyte sedimentation rate has returned to normal. He has been working for the past sixteen months and has been without his brace for seventeen months.

A long discussion regarding typhoid spine could be given, but the lowered incidence of typhoid fever and the rare occurrence of typhoid spine hardly make it necessary. Excellent publications by Murphy,<sup>5</sup> Freedman,<sup>1</sup> and McMaster<sup>4</sup> cover the subject fully. The interesting cases of Turner,<sup>6</sup> Wagenfeld,<sup>7</sup> Freedman, Guede and Arnous<sup>2</sup> and Keen (Case No. 17)<sup>3</sup> illustrate the complications of typhoid spine when suppuration occurs.

In conclusion, we should like to stress some of the unusual features of the case reported. The latent period, the interval between typhoid fever and the occurrence of the typhoid spine, varies from a few months to several years. Freedman quoted Puhl's case of having a ten-year latent period, while in the case reported it was twelve years before any symptoms occurred and twenty-two years before suppuration commenced. A suppurative typhoid spine is rare, but of even greater rarity was the extension of the suppurative process into the bronchus, subcutaneously on the back and into the pelvis in the form of a psoas abscess. Several of the cases quoted had

pelvic or posterior subcutaneous extensions of the paravertebral abscess, but none perforated into the bronchus or lung. Another interesting point was the marked cessation of toxic symptoms when treatment was started. The incision and drainage of the abscesses was helpful, but certainly inadequate considering such an extensive area involved; while the immobilization and bed rest were too short to receive full credit. We believe that the employment of sulfathiazole, even though the blood concentration was low, was responsible for the early cessation of toxic symptoms. And lastly, we believe the patient in the case reported was saved from a diagnosis of tuberculosis of the spine by the tenacity of the bacteriologist who refused to believe the presence of colon bacilli in the sputum was accidental.

We wish to express our appreciation to Dr. V. A. Dodd, Chief of Staff, Starling-Loving Hospital, for granting permission to report this case.

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# MASSIVE DELAYED HEMORRHAGE FOLLOWING TRAUMATIC RUPTURE OF SPLEEN AS A COMPLICATION OF FULL TERM PREGNANCY\*

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WAUGH and Prior<sup>1</sup> have just recently reported two cases of traumatic rupture of the spleen with delayed hemorrhage as a complication of rib fractures. They stress the fact that delayed hemorrhage is an unusual and extremely dangerous complication of splenic injury. McIndoe,<sup>2</sup> in 1932, reported forty-six cases of delayed splenic hemorrhage, including one of his own, and stated that "the syndrome of delayed hemorrhage following splenic rupture is definite and should include only those cases in which the primary rupture is followed by complete, or almost complete hemostasis for a latent period of more than forty-eight hours, and then a delayed hemorrhage of dramatic onset and fulminating character."

In this communication, we desire to report a case of massive delayed hemorrhage following splenic injury which occurred as a complication of full term pregnancy. No fracture of the ribs was noted in our case. In 1943, Waugh and Prior added twenty-four cases of delayed splenic hemorrhage including two of their own to McIndoe's reported series of forty-six. Inclusion of this case would bring the total reported cases of delayed splenic hemorrhage to seventy-one.

McIndoe also voiced the opinion that patients should be excluded who gradually sink under the influence of a slowly progressing splenic hemorrhage, even though

the duration of symptoms is more than forty-eight hours. The patient in this report carried on her normal daily activities for seven days following the injury, in spite of being in the latter part of the last trimester of pregnancy. Acute upper abdominal symptoms occurred on the seventh day, and resulted in her being hospitalized and splenectomy performed by one of us (C. I.) for acute hemorrhagic shock within eight hours after onset of the acute signs.

Of the seventy cases reported prior to this, only eighteen (or 26 per cent) had fractured ribs. As this addition to the series was a complication of a full term pregnancy, with no injury to the ribs, following an automobile accident, the percentage associated with rib fractures is reduced to 25 per cent. As far as can be determined from an analysis of the previously reported cases and a critical review of the literature since, this is the first case of delayed hemorrhage following traumatic rupture of the spleen occurring as a complication of pregnancy, that has been reported in the literature.

## CASE REPORT

G. S., a twenty-seven year old white female, was seen on the afternoon of July 21, 1943, by one of us (G. E.) after an automobile accident with no apparent injuries. She returned to the office the following afternoon complaining of

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slight pain in her left shoulder. Complete physical examination revealed no positive findings and no apparent fracture or dislocation of shoulder girdle. Fetal heart tones were normal. She was next seen on July 27th, and stated that the left shoulder pain was more severe, but otherwise she felt fine. An x-ray of the shoulder and chest was negative.

Her sister telephoned about 2:00 P.M. on July 29th, stating that the patient was not feeling well and was troubled by bloating, belching and fullness in the upper abdomen, which she thought was similar to previous attacks of gallbladder dyspepsia. The patient entered the hospital at 7:45 P.M. that evening, complaining of a very severe pain in the left shoulder in addition to weakness, shortness of breath and pain in the epigastrium. All previous examinations had revealed normal pulse and normal fetal heart tones. At this time, the patient was pale, apprehensive and very thirsty. The temperature was 97.6°F., pulse 144, and respiration 24. Examination revealed a distended abdomen with the fundus of a full term uterus just short of the ziphoid process, marked epigastric tenderness, dullness in flanks, diminished peristaltic sounds and a fetal heart rate which was very faint and almost uncountable. The red blood count revealed 1,370,000 cells with 5.6 Gm. of hemoglobin. The white blood count was 3,450. The urine was essentially negative. The diagnosis of acute hemorrhagic shock was obvious and immediate exploratory laparotomy advised, with rupture of the spleen as a likely etiologic factor, especially in view of the progressive left shoulder pain followed by acute onset of upper abdominal symptoms.

At 12:40 A.M. on July 30, 1943, under cyclopropane anesthesia the abdomen was opened through an upper left rectus hockey stick incision. The patient had received 250 cc. of plasma and 1,000 cc. of physiologic saline intravenously preoperatively and was receiving 600 cc. of whole blood from her husband as the incision was made. Her pulse was 120 and blood pressure 100/72 at this time. On opening the peritoneal cavity, dark red blood gushed forth over the fundus of the uterus. Approximately two quarts of blood, including clots, was salvaged, mixed with citrate and strained for possible use. After aspiration of blood and clots, the small residual space left in the upper abdomen and containing most of the gastro-

intestinal tract was packed off. Direct vision was not feasible when hands were in the operative field due to the small space between the fundus of the uterus and the lower costal margin. Therefore, with fingers of the left hand around the splenic pedicle to control further bleeding, the spleen was explored with the right, revealing an organ enlarged about two times its normal size with a large blood clot covering a transverse fracture of the convex surface. With the source of the bleeding verified, the pedicle was doubly clamped and ligated in the usual manner and the spleen removed. No further bleeding was noted, and the abdomen was closed in layers without drainage with interrupted braided silk in fascia. The patient's general condition seemed better, with a pulse of 100 and blood pressure of 120/80 at the close of the operation. She had been receiving only oxygen, continuously since the fascia had been approximated and this was continued postoperatively, supplemented by blood transfusions and gastric suction. The fetal heart tones at this time were still very rapid.

The patient's general condition remained precarious postoperatively, but signs of further bleeding were absent. Fetal heart tones slowed to 180 per minute after another transfusion and intravenous fluids. However, ten hours postoperatively, the patient began to complain of severe lower abdominal pain. Uterine contractions continued intermittently and thirty-two hours postoperatively a stillbirth female child was delivered by B.F.D. with low forceps and episiotomy with relative ease in a primipara. The patient developed a patchy type of atelectasis, which responded to carbon dioxide therapy and percussion interscapularly over the main bronchi, three days postpartum and five days postoperatively. The patient had an uneventful convalescence after the fourth postpartum and sixth postoperative day with pulse, temperature and respiration within normal limits. She was discharged on the twelfth postoperative day entirely healed and feeling well. Her red blood count after four whole blood transfusions was 4,430,000 with a hemoglobin of 12.3 Gm., and a white blood count of 35,000.

The pathologic report was traumatic laceration of spleen. A laceration of the convex surface extending into the pulp and covered by dark red blood clots was noted at the junction

of the upper and middle third and extended transversely across the entire convexity. The lower pole contained tiny subcapsular fibromas. The cut surface revealed several small and large hematomas in the pulp.

#### COMMENT

Waugh and Prior<sup>1</sup> state that delayed hemorrhage is an unusual and extremely dangerous complication of splenic injury. The above entity, a serious condition in its own right, may be complicated by other trauma or occur as a complication of other injuries such as fractured ribs or other normal conditions such as pregnancy. This patient was eight and one-half months pregnant at the time of splenic injury and at the time of surgery was in the latter third of the last trimester. The tremendous space filling ability of an almost full term uterus, undoubtedly, had a tremendous influence on the patient's favorable outcome, because of its effective tamponade on the wide open splenic venous sinuses by diminishing the size of the peritoneal cavity. Following the principle of Boyle's law relative to pressure changes of liquids in closed spaces when subjected to a decreased volume and in view of the low preoperative red blood count (1,370,000), it is doubtful if the patient would have survived to the time of operation if she had not been pregnant.

The postoperative red blood count in Waugh and Prior's<sup>1</sup> two cases took nineteen and twenty-two days, respectively, before reaching a 4,000,000 or higher level in spite of transfusion. This patient had a 4,430,000 red blood count with 12.3 Gm. of hemoglobin on the sixth postoperative and fourth postpartum day with three transfusions of 500 cc. of blood. The uterus, apparently, played the rôle of dual benefactor, not only by limiting the size of the space bled into, but also by autotransfusion of uterine blood thirty-two hours postoperatively after delivery of a stillbirth female infant. The patient lost less than three ounces of blood during delivery and it has been estimated that from 500 to

800 cc. of blood are reintroduced into the general circulation after the uterus firmly contracts down.

Delayed splenic hemorrhage is a definite complication of fractures of the ribs, especially on the left side. McIndoes'<sup>2</sup> series of forty-six were accompanied by ten fractures, having a total incidence of eighteen complicating rib fractures, or 26 per cent. No fracture of ribs was apparent in our case either by x-ray, physical signs or symptomatically. Waugh and Prior emphasize the frequent association of rib fractures in delayed splenic hemorrhage (25 per cent) and stress the fact that because of the more important and apparent abdominal symptoms, rib fractures may be overlooked, especially if asymptomatic. Much more important is the maxim that delayed splenic hemorrhage may go on to a fatality unnoticed in patients with rib fractures on the left side. Accordingly, in fractures of the lower right ribs, lacerations of the liver with immediate or delayed hemorrhage should be suspected until ruled out. Hinton and Steiner<sup>3</sup> in 279 cases of fractures of the ribs sufficient to warrant hospitalization, report twenty-nine fatalities or 10.4 per cent. Of the twenty-nine deaths only two were attributed to delayed splenic hemorrhage. Therefore, we wish to reemphasize the importance of the possibility of intra-abdominal injury occurring with fractures of the lower ribs. This is in view of the well known anatomical fact that the dome of the diaphragm rises to a level of the seventh and eighth ribs posteriorly, and fourth and fifth ribs anteriorly. In reality, the liver and spleen occupy the lower third of the thorax and are in juxtaposition to the ribs and thus very susceptible to any transmitted trauma to the bony thorax.

A snug Scultetus, many tailed, abdominal binder should be indicated as much preoperatively as intravenous blood transfusions so as to constrict the size of the peritoneal cavity. This was supplemented intra-abdominally in our case by the presence of a full term uterus.



Of the forty-six cases of delayed splenic hemorrhage reported by McIndoe<sup>2</sup> in 1932, seven patients died because of delay in operative interference. This high incidence is, undoubtedly, due to the fact that whole blood and plasma banks were not in vogue at that time. However, the availability of blood and plasma today should not be a legitimate reason for temporizing in acute splenic injury with hemorrhage as the peritoneal cavity will hold several quarts of blood. Every patient involved in an obvious clinical case of frank intra-abdominal hemorrhage should be operated upon immediately with blood and plasma started as one proceeds with the laparotomy. In doubtful cases every diagnostic procedure at hand should be utilized to reveal the presence of blood in the peritoneal cavity. Kehr's sign, or referred pain in the left shoulder, was present in our case with increasing severity from the second to the seventh day after the auto accident. Ballance's sign, consisting of increasing and non-shifting dullness in the splenic area and left lower quadrant of the abdomen and free fluid in the right lower quadrant, was also present during the last eight hours preoperatively. Wright and Prigot<sup>4</sup> recommend abdominal tap for free blood as a diagnostic aid and claim positive results in thirteen of the fifteen times it was used. This was not necessary in our case, but we believe that such a measure or a diagnostic peritoneoscopy may be indicated in possible splenic injuries. Peritoneoscopy is also indicated in perforating stab wounds of the abdomen or lower chest of doubtful nature, as recently reported by Hamilton and Duncan<sup>5</sup> in a series of traumatic cases. Immobility or elevation of the left diaphragm fluoroscopically, if present, is a valuable aid in diagnosis of subphrenic perisplenic hematoma.

The spleen has been definitely proven as not being essential to a normal lifetime and, therefore, splenectomy is obviously the therapy of choice in acute splenic hemorrhage. Any method short of this is

contraindicated because of the possibility of delayed hemorrhage from the rupture of a intrasplenic hematoma and reactivation of hemorrhage by walking, bending, coughing or sneezing, as has been cited in the literature before. This did not occur in our case as far as can be determined, although the patient spent the entire day preceding the operation canning vegetables.

The use of free blood in peritoneal or pleural cavities for autotransfusion has been previously suggested. Blood in the peritoneal cavity complicated by perforations of the bowel, or blood in the pleural cavity accompanied by laceration of the lung parenchyma have been accepted as contaminated sufficiently not to warrant reintroduction into the patient's vascular system. Approximately, 1,200 cc. of blood were salvaged in our case by citration and straining; however, enough blood was available so that its use was not necessary. Hamilton and Duncan<sup>5</sup> stress the reinfusion of salvaged blood even though grossly contaminated by bowel perforations if needed as a life saving procedure. Using this method, the source of the bleeding can be stopped immediately and the vitally necessary whole blood salvaged and utilized in spite of inavailability of donors. This procedure, no doubt, will lead to some complications, such as bacteremia or septicemia; however, if thoroughly citrated, strained through gauze and introduced with 5 Gm. of sulfadiazine, it will probably save more lives than waiting for an available donor.

Postoperatively, our patient developed a typical patchy type of atelectasis of the left lower lobe with tachycardia, fever and cyanosis. After delivery (thirty-two hours postsplenectomy) the patchy process extended and involved in addition the entire right lung field. Carbon dioxide inhalations, postural drainage and manual percussion had no apparent effect until the fourth postpartum day when she had a severe coughing spell, raised two table-spoonsful of thick, tenacious sputum and cleared spontaneously, both clinically and

symptomatically, within twelve hours. Her convalescence thereafter was uneventful and the patient was discharged on the tenth postpartum day.

McIndoe's criteria for the definition of delayed hemorrhage following splenic rupture are reiterated here only to help emphasize the distinguishing features between it and a slowly progressing splenic hemorrhage in which the patient gradually sinks, although the duration of the symptoms is longer than forty-eight hours. The syndrome of delayed hemorrhage following splenic rupture is much more of a definite entity, with complete interruption of signs and symptoms both clinically and otherwise for more than forty-eight hours. Our patient carried on her normal activities for seven days after her automobile accident with sudden collapse on the seventh night.

The question arises as to the mechanism of death of the fetus, which was delivered in a primipara thirty-two hours postoperatively, with relative ease and supplemented by low forceps and episiotomy. Less than three ounces of blood were lost during the entire procedure. The patient's red blood count immediately preoperatively was 1,370,000 cells. On the day between splenectomy and delivery, the red count was 2,600,000 with 8 Gm. of hemoglobin. On the second postpartum day it was 3,150,000 with 9.9 Gm. of hemoglobin. It seems probable that during the period of twelve to twenty-four hours while the red blood count was less than 2,000,000 cells, severe cerebral anoxia was, undoubtedly, present to a greater or lesser degree. Although this was tolerated well by the patient, and was supplemented by oxygen during operation and by nasal catheter postoperatively, the fetus' vital centers could have suffered irreparable damage during the several hours preoperative when no supplemental oxygen was being administered. At the time of operation, cesarean section was not deemed advisable due to the patient's condition. It was thought that cesarean section would be more dangerous to the mother than

would delay be to the fetus. It seemed reasonable to assume that with the bleeding controlled and with supplemental whole blood and oxygen, the fetal tachycardia would disappear. This it did during the next ten hours, although after this it gradually returned, accompanied by intermittent uterine contractions. Lutein and Pantapone were given. Delivery occurred thirty-two hours postoperatively.

The fetal heart rate remained consistently around 180 per minute, which is considerably above the normal range of 120 to 160 beats per minute. However, we frequently have seen the heart rate as fast as 180 or slower than 100 during labor in which the fetus was delivered, resuscitated without difficulty, and remained perfectly normal.

The diagnosis of ruptured spleen was not made until after the patient had suffered a very considerable hemorrhage and was in a state of shock. In spite of the slight possibility of being able to save the baby's life by doing a cesarean section at the time of the splenectomy, we elected to allow the patient to deliver from below in order not to increase the shock. The baby was alive at the time of the operation but apparently died within eight hours afterward. The cause of the fetal death is a question for speculation and it was our opinion that the cause of death was the very marked anemia of the mother, providing insufficient oxygen to maintain the fetus.

We were very much concerned as to the effects of labor on a patient having recently undergone a major operation. However, as has been noted in numerous other serious conditions complicating pregnancy at term, the labor was very easy. Dilatation of the cervix was accomplished within about four hours after onset of uterine pains. The patient was then transferred to the delivery room and a stillbirth female infant delivered very easily with low forceps, using light cyclopropane anesthesia. As has been noted, the blood loss was minimal.

Following the delivery, the patient seemed to be in good condition and was given another transfusion. About four hours later she became cyanotic, developed persistent coughing, and complained of pain in the chest. The physical findings were those of massive patchy atelectasis of the right lung, also partial atelectasis on the left. The treatment and results have been previously cited.

#### SUMMARY

A case of massive delayed hemorrhage, following traumatic rupture of the spleen, occurring as a complication of full term pregnancy with survival of the mother is reported.

This case was unaccompanied by fracture of the ribs and brings to seventy-one the series of delayed splenic hemorrhage reported in the literature.

Of the seventy cases of delayed splenic hemorrhage officially reported, this is

the first occurring as a complication of pregnancy.

The rapid rise of the patient's hemoglobin and red blood count postoperatively was attributed to the autotransfusion of uterine blood occurring after delivery.

The importance of early diagnosis and splenectomy in splenic injuries is re-emphasized.

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# CHEMOTHERAPY IN FROSTBITE\*

## CASE REPORT

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THE use of allantoin-sulfanilamide ointment using a specially developed, non-greasy, water-miscible base in surgery was first reported by Veal and Klepser.<sup>1-4</sup> They found that repeated topical applications of powdered sulfonamides tended to retard healing. The granulation tissues became sluggish, pale and dried out in appearance. By microscopic section of the granulating bed they demonstrated pale staining nuclei in most cells and a marked lack of blood vessel formation. The problem of controlling infection and at the same time encouraging more lively granulating tissues was solved by substituting for the powdered sulfonamides a non-greasy, water-miscible base containing 10 per cent sulfanilamide, which proved adequate to control infection, and 2 per cent allantoin to stimulate healthy granulation tissues. They concluded: "Microscopic evidence of greatly increased vascularity and healing seems to justify the addition of this drug (allantoin) to sulfonamide therapy in certain instances."

Lockwood<sup>5</sup> had shown that necrotic tissue and pus contain sulfonamide inhibitors which interfere with the bacteriostatic action of sulfonamides. The inhibitor substances were inactivated according to Wallersteiner,<sup>6</sup> by combinations of sulfanilamide-urea, and sulfanilamide-allantoin. In a report, Holder and MacKay<sup>7</sup> presented the results of wound therapy with urea-sulfonamide mixtures, and stressed the removal by the urea of gross sulfonamide inhibitors, or the source of such inhibitors in the form of necrotic tissue and pus.

Chemical débridement by means of al-

lantoin cleans the wound of those substances which tend to interfere with the bacteriostatic action of the sulfonamide, thus a suitable sulfonamide-allantoin combination not only frees the wound of the infectious process, but at the same time stimulates the growth of healthy granulation tissues.

Allantoin, as a stimulator of cell growth, was reported on by Macalister<sup>8</sup> who used extracts of comfrey root (which on chemical analysis were found to contain large percentages of allantoin) and pure allantoin solution, to treat indolent ulcers, which had failed to respond to all other types of therapy. His results convinced him of the efficacy of allantoin as a healing agent in these conditions.

The successful results obtained by Baer<sup>9</sup> in his maggot therapy, which were manifested by débridement of necrotic tissue and the rapidity of healing by the increase of healthy granulation tissues, was shown by Robinson<sup>10</sup> to be due to allantoin which was found in the excretions of maggots.

On the strength of the reports of Veal and Klepser<sup>1-4</sup> it was decided to try the allantoin-sulfanilamide ointment\* in a case of severe frostbite of the right hand.

## CASE REPORT

J. T., a white, fifty year old male, was admitted to the hospital on December 23, 1942, with severe frostbite of the right hand. He remained in the hospital until February 2, 1943. During his hospitalization, the right middle finger was amputated because of dry gangrene.

\* Allantomide ointment was supplied by The National Drug Company, Philadelphia, Pa.

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Due to very severe pains in the right hand, and areas of gangrene over the dorsal portion, the patient returned to the hospital on Febru-

For the relief of the severe pain, morphine  $\frac{1}{4}$  gr. was ordered at night and continued until March 15th. Venous occlusion (intermittent),



FIG. 1.

FIG. 1. Appearance of hand at start of allantoin-sulfanilamide ointment treatment (May 6, 1943).



FIG. 2.

FIG. 2. The gangrenous fingers sloughed off May 27th. Appearance of hand on June 24, 1943.



FIG. 3.

FIG. 3. Appearance of hand on August 28, 1943, with successful skin graft.



FIG. 4.

FIG. 4. Appearance of hand at time of discharge from hospital.

ary, 16, 1943. An x-ray examination on admission revealed the following: (1) Phalanges of little finger missing; (2) distal phalanx of second finger missing; (3) decalcification of carpal bones and proximal ends of metacarpal bones, and (4) considerable pus in the palmar area.

Wasserman and Kahn tests were negative.

Blood irradiation treatments were given on February 17th and 18th with no apparent benefit to the patient.

The patient was transferred to the department of surgery on February 25th. His temperature was  $102^{\circ}\text{F}$ . A continuous septic temperature persisted until April 3rd when it became normal and remained so until released.

one minute on and two minutes off, was started immediately, and continued until June 25th.

Blood cultures taken on April 2nd were negative.

Because of the low red blood cell count, a transfusion of 500 cc. of citrated blood was given on May 6th, and allantoin-sulfanilamide ointment therapy started.

Figure 1 shows the condition of the hand at the time of starting allantoin-sulfanilamide ointment treatment. Although the fingers were gangrenous, and the palmar surface was covered with slough tissue, these were not disturbed. The ointment in a liberal amount was applied over the whole hand and wrist, and then

dressed with vaseline gauze and dry dressings. These dressings were changed after four days, the hand was gently bathed with hydrogen peroxide, and fresh ointment applied. Dressings were changed at four to five-day intervals, the hand being bathed at each dressing period with hydrogen peroxide to remove adherent ointment and loose slough tissues. On May 27th, all of the fingers sloughed off, and there was evidence of epithelization on the dorsal aspect of the hand. The thumb was folded under the site of the index finger and was attached. On June 10th, the palmar surface was completely sloughed and was trimmed to some degree with forceps and scissors. By June 24th, the palmar area was clean of all slough tissue, and epithelization was evident. (Fig. 2.)

It was decided on August 5th, that the hand was in good condition for skin graft. The skin graft operation was performed on August 16th, at which time the thumb was separated from the palm. Allantoin-sulfanilamide ointment with a light pressure dressing was applied. A change of dressing on August 28th revealed an excellent take of the graft. (Fig. 3.) The patient was discharged from the hospital on September 21st. (Fig. 4.)

During the whole course of the allantoin-sulfanilamide ointment treatment, laboratory tests for urine and blood sulfanilamide levels were made frequently. At no time during the treatment were sulfanilamide crystals found in the urine. Determination showed 2.4 mg. per cent sulfanilamide in the blood May 9th, and 2.3 mg. per cent on June 2nd. After venous occlusion treatment was discontinued (June 25th); blood determinations for sulfanilamide showed only traces of the drug.

#### SUMMARY AND CONCLUSION

A case of frostbite is presented. It is believed that the institution of the allan-

toin-sulfanilamide ointment treatment in the case reported was a big factor in saving the patient's hand. The ointment, by chemical débridement due to allantoin, completely cleansed the hand of sloughed and devitalized tissue and stimulated new granulation tissues and epithelium. Infection was definitely brought under control. The results obtained in this case indicate that allantoin-sulfanilamide ointment in a specially prepared, non-greasy, water-miscible base is worthy of a trial in the treatment of severe frostbite.

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# SPASTIC CALCANEOCAVUS FOOT DEFORMITY\*

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SPASTIC paraplegia generally produces an imbalance of the opposing muscles of the hip, knee or ankle with resultant deformities. Occasionally, however, the intrinsic muscles of the foot are involved producing a deformity which makes walking very difficult. Overstimulation of the medial and lateral plantar nerves produces a hyperactivity of the intrinsic muscles with marked flexion of the toes at the metatarsophalangeal joints and extension at the interphalangeal joints. This position may be correctible passively or it may be fixed and unable to be corrected manually. In the former type of case, a Stoeffel operation alone may succeed in re-establishing muscle balance and correcting the deformity. In the latter case of fixed contracture, however, tenotomy, capsulotomy, and muscle stripping will be necessary to correct the deformity. In addition, neurotomy of the motor branches of the medial and lateral plantar nerves will tend to re-establish muscle balance and thereby prevent a recurrence of the deformity.

The medial plantar nerve supplies the abductor hallucis, the flexor digitorum brevis, the flexor hallucis brevis and the first lumbrical. The lateral plantar nerve supplies the rest of the intrinsic muscles of the foot, its distribution being similar to that of the ulnar nerve in the hand. Section of the motor branches of the lateral plantar nerve will tend to correct the imbalance of all the toes except the great toe. In order to reduce the contracting action of the flexor hallucis brevis, its motor branch from the medial plantar nerve must be sectioned. The abductor hallucis tends to flex the proximal phalanx as well as abduct it. Its motor branch should also be sectioned. Fear of resultant

muscle imbalance due to unopposed action of the antagonistic adductor hallucis is unwarranted, since this latter muscle is also deprived of its nerve supply by sectioning the deep motor branch of the lateral plantar nerve.

The case to be reported is one in which flexion contraction of all the toes was present with marked fixed flexion contracture of the great toe only. The fixed contracture was corrected by plantar capsulotomy at the metatarsophalangeal joint as well as tenotomy of the double insertion of the flexor hallucis brevis. Neurotomy of the motor branches of both plantar nerves was then performed. In view of the cavus deformity of the foot, a Steindler plantar stripping was also performed. The resultant cosmetic and functional improvement was gratifying.

## CASE REPORT

G. C., male, aged twelve years, was first seen in the dispensary at Sydenham Hospital, in April, 1941. He presented a spastic paraplegia due to congenital lues. Both his mother and maternal grandmother were treated for lues. The birth history indicated a full term infant delivered normally. He talked at eight months and walked at thirteen months. He was well until the age of three years (1932) when he developed pain first in the right leg and shortly thereafter in the left leg. At the age of four years (1933) he was operated upon elsewhere for bilateral spastic pes equinus. Bilateral lengthening of the tendo-achilles was performed. Three years later (1936) similar procedures were again performed. Following each of these procedures, the patient's gait improved temporarily. In addition to the foot disability, he suffered from repeated epileptiform seizures.

When seen by me in 1941 the right foot presented a marked calcaneocavus deformity. In addition all the toes were in plantar flexion

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at the metatarsophalangeal joints with extension at the interphalangeal joints, i.e., intrinsic flexion deformity. The great toe was in flexion

was due to shortened and taut flexor hallucis brevis as well as to a tight capsule. When an attempt was made to extend the toe



FIG. 1. A, lateral view before operation. Note marked plantar flexion at the metatarsophalangeal joints; also calcaneocavus deformity. B, anteroposterior view before operation. Note subluxation at metatarsophalangeal joints.

contracture position of about 45 degrees. With considerable force it could be extended only about 10 degrees passively, i.e., to a position of minus 35 degrees. The flexion contracture

passively, a clonus was set up. The second toe could be extended passively to minus 5 degrees. Both great and second toes presented a plantar subluxation at the metatarsophalangeal



joints. The third, fourth and fifth toes could be extended completely passively. The plantar structures of the foot were markedly taut.

great and moderate plantar flexion of the second toes at the metatarsophalangeal joints. A calcaneocavus deformity was also noted.



FIG. 2. A, lateral view after operation. Note over-correction following tentotomy, capsulotomy and neurotomy. B, anteroposterior view after operation. Note correction of subluxations.

As the patient walked, he bore his weight on the heel and terminal ends of the flexed toes. The ball of the foot was elevated off the floor so that no weight was borne on the metatarsal heads. The gait was typically spastic and the toes scraped along the floor. The second toe overlapped the great toe.

X-rays of the right foot dated March 31, 1941, revealed marked plantar flexion of the

The patient was admitted to the hospital for section of the motor branches of the median and lateral plantar nerves; section of the flexor hallucis brevis insertion; plantar capsulotomy at the metatarsophalangeal joint of the great toe; and Steindler stripping of the os calcis.

1. On April 18, 1941, under tourniquet control, a  $2\frac{1}{2}$  inch longitudinal incision was

made along the medial aspect of the heel beginning at the posterior aspect of the heel and extending forward to the apex of the longitudinal arch of the foot. The skin and fascia were dissected from the undersurface of the plantar fascia. The medial border of the abductor hallucis muscle was dissected exposing the medial plantar nerve as it passes under cover of the muscle. By retracting the muscle plantarly, the nerve could be isolated and dissected free exposing the motor branches to the abductor hallucis, the flexor brevis digitorum, and the flexor brevis hallucis muscles. These nerve branches were identified by stimulating them with tissue forceps, producing a contraction of the muscles supplied by them. The nerve branches were then sectioned. The plantar fascia was then incised transversely close to its origin at the os calcis. The underlying abductor hallucis, flexor brevis digitorum and abductor digiti quinti muscles were then sectioned close to their attachment to the os calcis and stripped forward with a blunt elevator to the calcaneocuboid joint. The wound was then closed.

ii. A  $2\frac{1}{4}$  inch incision was then made along the medial aspect of the head of the first metatarsal, curving transversely into the plantar crease at the base of the big toe. The skin flap was retracted plantarly exposing the flexor hallucis longus tendon. By retracting this tendon, the two tendons of insertion of the flexor brevis hallucis were exposed as well as the capsule of the metatarsophalangeal joint. The flexor brevis tendons were sectioned and a plantar capsulotomy performed. The marked flexion deformity of the great toe could then be easily corrected. The wound was closed.

iii. A  $2\frac{1}{4}$  inch longitudinal incision was made on the plantar surface of the foot at the junction of the medial and lateral thirds of the foot. The incision began about  $\frac{1}{2}$  inch proximal to the level of the tuberosity of the fifth metatarsal bone and extended forward. The tuberosity of the fifth metatarsal bone marks approximately the level where the lateral plantar nerve divides into the superficial and deep branches. The incision was deepened bluntly between the flexor digitorum brevis and the abductor digiti quinti muscles, exposing the lateral plantar nerve in the depth of the wound.

The nerve was isolated and dissected exposing the deep and superficial branches as well as the proper digital branch of the superficial

nerve. The latter supplies the flexor digiti quinti brevis and the two interossei of the fourth interspace. This was sectioned as well as the deep motor branch which supplies the remaining interossei, the adductor hallucis and the second, third and fourth lumbricales. The wound was closed and the remaining toes were manipulated. A plaster of Paris cast was then applied from the toes to below the knee with the ankle at 90 degrees and the toes in corrected position.

Following the operation, the patient had several epileptiform seizures which were controlled with luminal. Postoperative roentgenograms dated April 21, 1941, revealed complete correction of the flexion contractures at the metatarsophalangeal joints of the great and second toes. Some flexion was noted at the interphalangeal joint of the great toe. On May 1, 1941, the patient began to walk with crutches. On June 9th, the plaster cast was removed and a regular shoe applied. On June 16th, the patient was walking quite well without support. Posture of the foot was greatly improved and he was able to place the foot completely on the floor so that weight was borne on the metatarsal heads as well as on the heel. The patient was last seen on December 22, 1942. The correction of the right foot had been maintained and the patient was able to walk quite well. He was still troubled with epileptiform seizures, but between attacks he was able to get around satisfactorily.

#### SUMMARY

A case of intrinsic muscle imbalance of the foot due to spastic paralysis has been described. Although the patient presented a calcaneocavus deformity as well as marked flexion contracture at the metatarsophalangeal joints, it was the latter deformity which primarily caused his disability. Because of this, he was unable to bear his weight fully on the plantar aspect of the foot. This was corrected by tenotomy and capsulotomy, and recurrence of the deformity has been prevented by neurotomy of the motor branches of the median and lateral plantar nerves.

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# DUODENAL ATRESIA IN THE NEWBORN

## CASE REPORT

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IN a survey of the literature on any subject, one of the first obstacles encountered is the looseness in terminology used in describing certain conditions. The term "intestinal obstruction" is used to designate the blocking or clogging of the lumen of the intestinal tract which hinders the passage of its contents. Such terms as atresia, occlusion, stenosis and aplasia are found to be used interchangeably with much confusion as to just what type of lesion was being described. The word atresia as derived from the Greeks means "without a boring," or, to us, an imperforation, absence or a closure of the intestinal lumen. However, it is often used to mean occlusion or any congenital obstruction, whether it be intrinsic or extrinsic. Atresia presupposes the presence, sometime in the development of the bowel, or a lumen of which there is subsequently complete (occlusion) or partial (stenosis) obliteration. In this report the word occlusion will be used to mean a complete congenital intrinsic closure of the lumen of the intestinal tract. Misuse of terminology, therefore, makes the statistics on a number of cases of this type of lesion very confusing, and on this basis some publications may have been missed in the bibliography of this paper.

Duodenal obstruction in the newborn is either congenital or acquired. The acquired type is either (1) mechanical, such as seen in hernia, volvulus and Meckel's diverticulum, or (2) adynamic or neuromuscular in character or much the same in origin as Kirschsprung's disease is thought to be. The etiology of the congenital forms of obstruction is still in the theoretical stage. One theory is that it is due to the failure of the bowel to acquire a lumen during the course of development

or that the lumen is obliterated by proliferation of the epithelium. Another is that the obliteration is inflammatory. Ladd and Gross tend to believe that the etiology is due to failure in opening of the lumen during embryonic life.

Until recently, all cases of duodenal occlusion were fatal, regardless of what form of treatment was instituted. Cordes, in 1909, and Spriggs, in 1912, had a very excellent review of literature up until that time and found no successful cases published. In 1913, Webb and Wangenstein published a paper in which nine cases had been operated upon successfully for some form of upper intestinal obstruction. Five of these cases were some form of occlusion of the duodenum. All the reviews through 1912 presented a completely hopeless aspect as far as treatment of this condition is concerned. As far as we can ascertain only fifteen patients with complete atresia of the duodenum have survived operation. This review is incomplete and presented at this time to show that what appeared to be a hopeless situation a few years ago is now beginning to show some degree of encouragement.

## CASE REPORT

The patient, an infant, was born September 11, 1943, in St. Vincent's Hospital. Its weight at birth was seven pounds and four ounces. It was noticed that after the first feeding the infant vomited the entire amount. This continued after each feeding, regardless of whether it was breast, house formula or plain water. All vomitus was bile stained. On the third day, a pediatrician was called in and a tentative diagnosis of pyloric stenosis or obstruction of the duodenum was made. On September 15th, an x-ray of the stomach was made using barium as contrast media which showed a complete obstruction between the second and third part

of the duodenum with considerable ballooning out of the first part. In the discussion of this case, the differential diagnosis was between an

jejunostomy was done using No. 0000 chromic intestinal sutures for the inner and outer tiers, the latter being reinforced with cotton "a"



FIG. 1. X-ray picture of stomach, barium sulfate contrast, fifteen minutes after taking, shows normal duodenum cap, but ballooning out of first part of duodenum, with complete atresia of second portion. Note there is no gas patterns in either the small or large intestines.

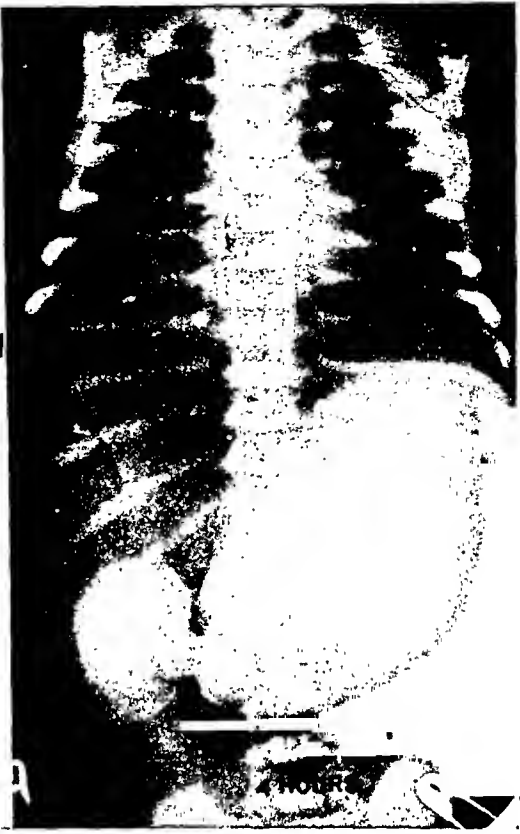


FIG. 2. Picture taken four hours later shows no entering of stomach.

obstruction of the duodenum at the ligament of Tritz by a peritoneal band, volvulus of the duodenum or pyloric stenosis, the latter probably being ruled out by the presence of bile in the vomitus.

The infant was prepared for surgery by the administration of adequate fluids and gastric lavage to decompress and clear the stomach of all barium. On September 16th, the operation was performed under light ether anesthesia. The pylorus was found to be normal. However, the first part and the proximal half of the second part of the duodenum was ballooned out, showing an obstruction somewhere in the second or third portion of the duodenum. The ligament of Tritz was normal and no obstruction found at this point. A posterior gastro-

interrupted sutures. The incision was closed with cotton sutures. A transfusion of 50 cc. of whole citrated blood was given the same day of operation. A stomach tube which was placed in prior to operation was left in for irrigation with warm sterile water at one hour intervals. Some old blood and barium were washed out.

On the night following the operation the patient began to bleed from the incision. Two mg. of vitamin K was given at that time and repeated three times a day for two days. The hemorrhage stopped shortly after the first injection and did not re-occur. Another transfusion was given on the third and sixth postoperative days. On the third postoperative day the stomach tube was removed, and the administration of  $\frac{1}{2}$  oz. sterile water every three hours was begun. This was retained fairly well by the patient and on the fifth day Similac, same amount, was substituted. This was gradually increased up to normal feedings for

the infant's age on the tenth day. On the twelfth day the patient began to gain weight and to have normal bowel movements and was



FIG. 3. Picture taken thirteen days after operation shows the ballooning out of the duodenum still present. However, there is emptying through the posterior gastrojejunostomy.

dismissed on October 25th. Its weight was 8 pounds 13 ounces and appeared to be normal in all respects. Rechecks on patient at two months, four months and six months show it to continue to gain weight and take its food normally.

In the discussion of the treatment of duodenal occlusion one finds that the only treatment that has been satisfactory is either a gastrojejunostomy, duodenoduodenostomy, or duodenojejunostomy with the latter being preferred by most men. In reviewing the literature it was found that all cases which were not treated in this manner were fatal. As pointed out by Ladd and Gross and in other papers,

the infant cannot tolerate tubes in the small intestine for feeding purposes as is often used in upper intestinal obstructions in adults. No patients who had tubes inserted survived. This is probably due to the delicate fluid balance that one encounters in the infant. The infant does not tolerate the loss of essential body salts as well as the adult does. When death follows such operations, there is pronounced dehydration, inanition, and gradual wasting with a terminal pulmonary infection. Not only is this true of duodenal or upper intestinal obstructions, but in all cases of obstruction to any part of the bowel. The infant will not tolerate a Micklet's type of anastomosis as the adult does, and it is found advisable in cases in which resection of the intestine is indicated that it be done in the one-stage instead of the two- or three-stage operation. It is surprising to note that the infant can survive this one-stage operation so well. A very important fact to mention is that the duodenum should never be explored. The intestine is usually edematous at this point, due to the stretching of the wall and will break down and the patient die of peritonitis.

Certain precautions should be observed in surgery in infants. These precautions have been pointed out in several publications, but are so important that they cannot be mentioned too frequently. These are: (1) *preoperative care*. It is very important that adequate fluid balance be obtained prior to operation. Most patients who require intestinal surgery are first seen in a dehydrated state due to persistent vomiting and operation while in this state is dangerous. It usually requires only a few hours to obtain adequate balance, and regardless of the seeming emergency of the operation, the time spent in preparation will bring reward. (2) *Anesthesia*. Most men doing pediatric surgery prefer light ether anesthesia, by the open drop method. Some precautions that might well be used are (1) wrapping the extremities in padded cotton to prevent

the escape of body heat which is more apt to occur in infants; (2) having the operation room warm; (3) using vitamin K intramuscularly should be routine as it helps to prevent the capillary oozing which is often very marked in these cases; (4) postoperative care. Infants should receive plasma and whole blood transfusions following any surgery on the intestinal tract. This helps build the patient up and also helps to prevent edema at the sight of anastomosis. The stomach should be repeatedly washed out and aspirated as long as there is any tendency to vomit.

#### SUMMARY

Up until recently, all cases of duodenal occlusion in the newborn were found to be fatal regardless of what form of treatment was instituted. However, the present form of treatment, which consists of a short-circuiting operation of the obstruction with duodenojejunostomy, is the preferred operation. It is noted that this surgery must be done early since the infant dies from dehydration and other complications of intestinal obstruction quite early.

#### CONCLUSIONS

1. Duodenal occlusion in the newborn is amenable only to surgery.
2. Surgery must be performed early.
3. Only short-circuiting operations should be performed.

4. Exploration of duodenal is not advised.

5. Preoperative and postoperative care is very essential.

6. With this publication only sixteen patients have survived.

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# SOLITARY CYST OF THE KIDNEY\*

## CASE REPORT

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THE correct diagnosis of a solitary cyst of the kidney is seldom made pre-operatively. Most reported cases have

This tumor is usually found during early adult life and found equally in men and women. It is in most cases a large cyst,

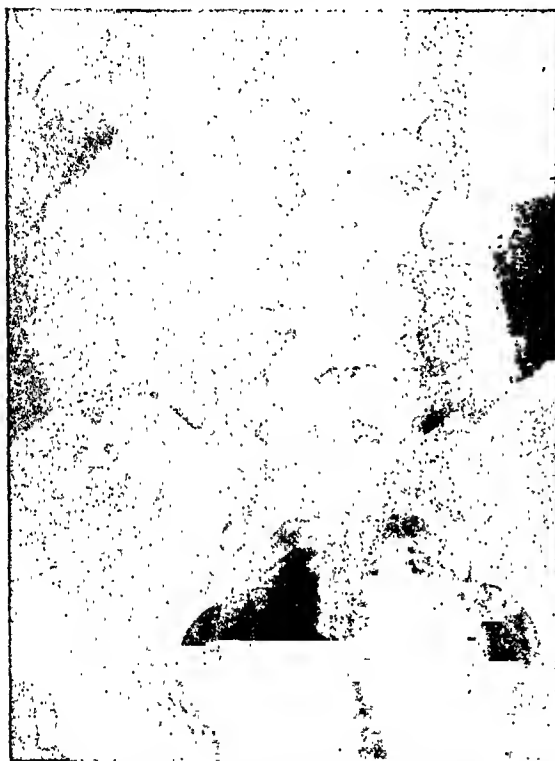


FIG. 1. Flat plate showing large cystic mass attached to the lower pole of the right kidney.



FIG. 2. Normal pyelogram; cystic mass attached to the lower pole.

been found during surgical procedures for other conditions and others have been added at the autopsy table. Although diagnosed as early as 1634, Lowsley and Kirwin<sup>1</sup> in reviewing the literature, have collected only a little over 300 cases. In 147,657 admissions at the Beth-El Hospital, this is the second instance of a solitary cyst of the kidney, one having been reported by Dr. A. L. Greenberg<sup>2</sup> in 1939. Cases have been reported by Herbst and Polkey<sup>3</sup> and by McCrea.<sup>5</sup>

more commonly at the lower pole of the kidney. The most favored theory as to its etiology is that it is probably congenital. Others believe that it is a retention cyst occurring after tubular obstruction.

Pathological study<sup>1</sup> shows a cyst, which is unilocular or rarely multilocular, with a clear yellowish watery fluid which contains albumin, epithelial cells, leucocytes, chlorides, urea, and occasionally blood. The cyst wall has remnants of glomeruli and is composed of dense fibrous tissue

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with areas of calcification, and lined by flattened epithelial cells.

There is no characteristic syndrome to aid in the diagnosis. Subjectively, the patient may complain of a feeling of discomfort, or experience a sharp pain as excruciating as that of renal colic. Occasionally, blood may be found in the urine. On examination, one may find a large mass in the abdomen, apparently attached to the kidney, and x-ray may show distortion of the pelvis, calices, or ureter, depending upon the size of the cyst. It is usually the negative findings such as normal pyelogram, normal urine, and normal blood chemistry, which aid in the diagnosis. The treatment is surgical when the diagnosis is established.

#### CASE REPORT

S. S., female, aged thirty-eight, was admitted to the Beth-El Hospital on June 24, 1943. She had been in excellent health until two months prior to admission, when she experienced a sudden sharp pain in the right upper quadrant of the abdomen, associated with a feeling of fullness and nausea. She subsequently had three similar attacks. There was no frequency of urination, no dysuria, and no pain referable to the kidney area. The history was otherwise irrelevant.

Physical examination, on admission, showed the head, heart, and lungs to be normal. Examination of the abdomen revealed a mass the size of a large grapefruit, which felt cystic and was moderately tender to palpation. There were no other positive findings abdominally. Vaginal examination was negative, and showed both ovaries and the uterus to be normal, ruling out the possibility of a large ovarian cyst.

X-ray studies in the form of a flat plate of the abdomen (Fig. 1) revealed a large cystic mass which appeared to arise from the lower pole of the right kidney. Pyelography was negative. (Fig. 2.) Urinalysis revealed the following: Specific gravity 1022; albumin, sugar, and acetone negative; microscopy showed several scattered white blood cells. Blood studies showed white blood corpuscles 8,700; polymorphonuclears 75 per cent; lymphocytes 24 per cent; red blood corpuscles 4,250,000; hemoglobin 86 per cent; urea nitrogen 14 mg. per cent; creatinine 1.5 mg. per cent.

Diagnosis of a congenital cyst of the right kidney was made and operative intervention was decided upon. Under spinal anesthesia, a



FIG. 3. Low power magnification of cyst wall, a fragment of kidney tissue.

right rectus incision was made and a large cyst of the lower pole of the right kidney measuring 16 cm. in diameter was revealed. The peritoneum of the posterior abdominal wall was split, the cyst was enucleated and resected from the kidney, and the raw area packed with retroperitoneal fat to control bleeding. The postoperative course was uneventful, and the patient was discharged on the tenth postoperative day in good condition.

The pathological report by Dr. Mendel Jacobi is as follows:

**Macroscopic Description:** The specimen is composed of an empty collapsed thin transparent solid cyst apparently 6 cm. long, 3 cm. in diameter, its inner surface folded and glistening; a small fragment of what appears to be kidney tissue is attached at one end.

**Microscopic Description (Figs. 3 and 4):** The cyst wall is composed of dense acellular fibrous tissue, the cyst surface is lined only in part by a single layer of regularly arranged atrophic and flattened cuboidal epithelial cells resembling those found in the tubules. At one end of the section is a fragment of kidney tissue showing a moderate stromal fibrosis and focal lymphocytic infiltration.



The glomeruli in the fragment of renal tissue show varying degrees of fibrosis; the larger arteries similarly show mural thickening and

preoperatively, is reported with a brief description of the diagnosis, pathology, and treatment.



FIG. 4. High power magnification of cyst wall, atrophic cuboidal lining epithelium.

fibrosis and lumen stenosis. At a distance from the cyst lumen, the renal tissue shows no histologic changes other than a slight interstitial lymphocytic infiltration. Diagnosis: Congenital cyst of the kidney.

#### SUMMARY

A case of a solitary unilateral congenital cyst of the right kidney in a thirty-eight year old woman, diagnosed

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## PHYSIOLOGY OF THE UNSHOD AND SHOD FOOT WITH AN EVOLUTIONARY HISTORY OF FOOTGEAR

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ALL physicians are constantly confronted by baffling functional foot troubles. The public is assailed by advertisements claiming a certain shoe feature or pedigree of endorsement has "the answer to the maiden's prayer" (used advisedly.) Yet no inquiry I know of approaches the problem analytically; no shoe that I have found fits every foot, relieves all pain, delights every eye. It would seem that the fundamental problems are to determine (1) the elemental physiology of the human foot; (2) the reason for being of the several types of foot gear; (3) the effect of each innovation on foot physiology; (4) to suggest logical solutions for the common difficulties.

In the unshod Polynesians, Melanesians and Micronesians that I have observed, there are four overlapping but distinct phases of foot activity, which differ only in degree from other individuals who are accustomed to walking unshod a part of the time.

### PHYSIOLOGY OF THE UNSHOD FOOT

*The contacting phase* which is universally initiated as the heel strikes the ground<sup>32</sup> is followed by sequential contact of the fifth and first metatarsal heads. This, so far as the foot is concerned, is a passive act, as the contacts are made by the body coming over the grounding foot.

*The primary prehensile phase* begins just before the head of the fifth metatarsal is grounded and ends just as the head of the first metatarsal makes contact. It

consists in an active dorsiflexion of the toes at the proximal joint, while the distal joints are kept extended. The toes tend to spread as they are dorsiflexed. This act permits of phalangeal adjustments to surface irregularities such as pebbles.

*The postural or weight bearing phase* corresponds to standing, and occurs during the brief period while all three major weight bearing points are in contact with the ground. It is during this stage that the foot lengthens and widens slightly. One may feel the postural contraction of the abductors hallucis and minimi digitii and the adductor hallucis. These contractions are in response to proprioceptive reflexes caused by the spreading of the pedal tripod. The tension in the abductors ceases abruptly as the heel leaves the ground. It should be noted that proprioceptive end organs are said to be most plentiful in the small muscles of the feet and hands.<sup>33</sup> Thus, the foot is essentially a tripod held in a normal relationship by reflex activity in the intrinsic muscles of the foot. It is not a bag of bones held together with ligaments. The vaunted arches are incidental to its structure and of no more essential importance than the tilt of the tip of one's nose or the color of one's iris.

*The propellor phase* begins as the postural phase ends. It is characterized by a passive dorsiflexion of the extended toes at the proximal joint, and an active contraction of the toe flexors and tightening of the plantar fascia. It is this potential flexion

which gives them the bite essential for propulsion. As the dorsiflexion begins all the toes are grounded; as flexion increases the toes are successively raised from the ground, beginning with the fifth. Generally, the great toe (but frequently the second toe) appears the longest. Except in extreme instances functionally the great toe is always the longest, by reason of the fact that its head is elevated on the sesamoids projecting it functionally well beyond the second metatarsal head. In club feet and metatarsus varus the first metatarsal is frequently very short, and the attempt to ground it tends to cause a persistent varus. Lifting the head of the first metatarsal on a pad tends to improve the gait.

It would appear, therefore, that for maximum pedal efficiency it is essential that (1) the weight bearing points should be permitted normal spatial and chronological contacts; (2) the toes be permitted full active and passive dorsiflexion; (3) the foot be allowed to lengthen and broaden normally.

#### DEVELOPMENT OF SHOES

The story of "Shoes" is a drama filled with discomfort and vanity, suffering and disease, wars and wounds, trials and errors. Of their origin we cannot speak. The earliest known shoes were used in Egypt about 3500 B.C. Their preservation tells not of beginnings but of a preserving aridity through five millenia and more. Their finished workmanship reveals master hands in long established trades.

The appearance of unique but related types of footgear either reveals the shod marches and voyages of pre-history, or the independent development of similar solutions in geographically and ethnologically unrelated areas. We may not trace the sequential history of the shoe's development in early days, but we may glimpse the effects of temperature, precipitation, terrain, and comparative cultural development.

Each people used the materials at hand

—the Polynesians and Egyptians native basts, the Europeans basts, wood and leather, the Eastern Orientals wood, basts and cloth.

So far as I can determine, tropical jungle dwellers are unshod peoples. Here they have the rotting carpet of the forest glade, and soothing mud by cooling streams. Keith<sup>22</sup> found any type of shoes unnecessary and uncomfortable save for tender feet, and considered the dangers of the forest folk the lesser of two evils.

Desert dwellers everywhere seem to have found untempered heat a trying problem for their feet. Their answers differed with other factors, as rainfall. The Egyptian's problem was simplest and he developed a simple answer. While sandals are found as far back as the middle of the fourth millenium B.C., it was not till the age of the builders of the pyramids (Dynasty V, 2750-2625 B.C.) that sandals began to be used semi-routinely by the ruling classes bespeaking a relationship between hot stones and tender feet.

The sole of the Egyptian sandals generally consisted of wood, leather or fibers; some of the latter are like beautifully wrought pieces of basketry. These were retained by a T-strap (Fig. 1) whose stem passed through the sole between the great and second toes, and the arms were attached to the sole beneath the malleoli. An interesting and unusual variation is found in the sandals of Wah (2000 B.C.) (Fig. 2) now in the New York Metropolitan Museum. These consist of a flat wooden sole about a quarter-inch thick. A properly placed (2 to 2½ inch) quarter-inch dowel toe pin was thrust through the sole at an angle of 45 degrees. Similar pins about one inch long were set beneath each malleolus. Through the tips of these pins and completely surrounding the foot was a half-inch band of thin pliable material.

Egypt is an arid land where rain is held a curse. Only the flick of a toe lay between the slap of Pharaoh's sandals in Karnak's sunburnt courts and the padding of his naked feet in that holy temple's shadowed

halls. In semi-arid Mesopotamia, on the contrary, there is five to ten times the rainfall of Egypt, and the lightly held

giving the water an additional purchase on the sandal. The Polynesian caught a heel strap through loops beneath the malleoli

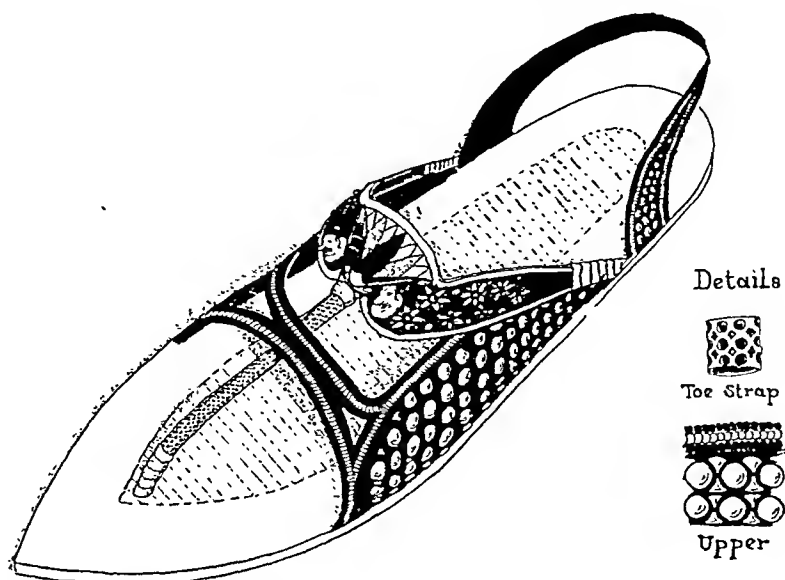


FIG. 1. Sandal of Tutankhamen (1350 B.C.). Reconstruction of most elaborate of sandals found in his tomb. Most Egyptian sandals omitted the uppers and quarters. Drawings made from photographs in Carter's "Tomb of Tutankhamen." It appears to have been made of basts, cloth, metals, and either enamels or jeweled inlays.

sandals of Egypt would be lost in the occasional mud of Assyria. This altered both problem and answer. Instead of the T-thong, the forepart of the sandal was fastened on by a loop through which the great toe was slipped. (Fig. 3.) This thong, if one may judge from bas-reliefs, crossed on the dorsum of the foot and was then caught through loops on either edge of a leather quarter, an innovation which held the heel in place, preventing both the familiar sandal slap and the easy discarding of sandal at the portal.

The Polynesians on their coral-wreathed volcanic islets were confronted with two problems: (1) the knife-like coral of their fishing ground, and (2) the aa (Polynesian and geological term for rough or jagged) lava of their island homes. The problems of the reef furnished a variant of the Babylonian solution. Their sandals had to be retained not against the pull of inert mud, but of rushing water. It was necessary that the heel be fastened on, but a solid Babylonian counter would form a cup,

and tied the thong around the ankle. This gave no obstruction to the movements of the sea. However, the free lateral border of the ancient form of sandal would be subject to some dragging force. To meet this a second interdigital thong was introduced between the fourth and fifth toes. The Cook Islanders<sup>6</sup> and Maoris<sup>7</sup> put the fixed loop behind the heel and the long tying thongs came between the toes. The Hawaiians used the fixed loop between their toes with the tying thongs at the heel. (Fig. 4.) The Maoris caught the lacing thongs through several lateral loops in the manner of the Greek and Roman.

It should be observed that the Mayans used the same principle of a double toe thong, but living inland they used a solid counter. (Fig. 5.) They, however, ran the lateral thong between the third and fourth toes. I do not know the ethnological significance of these facts.

Both coral and aa lava caused rapid wearing of the bast soles of the Polynesians. Buck<sup>6</sup> quotes Skinner<sup>11</sup> to the

effect that on some expeditions each individual carried from five to twenty pairs of sandals.

All of these solutions were aimed at one thing—plantar protection—protection against heat, geological formations and

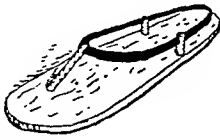


Fig. 2.

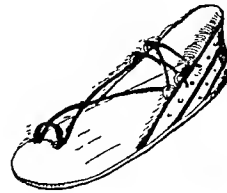


Fig. 3.

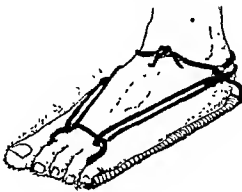


Fig. 4.



Fig. 5.

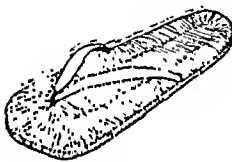


Fig. 6.



Fig. 7.

FIG. 2. Sandals of Wah—2000 B.C. Metropolitan Museum, New York. Wooden sole and pegs; leather strap; not commonly found.

FIG. 3. Sandals of Assyria, 750 B.C. Probably all leather. Note toe ring and solid quarter. Reconstructed from statutes and descriptions. The quarters were alternately striped, frequently black and red.

FIG. 4. Bast sandals of Hawaii. Bishop Museum, Honolulu.

FIG. 5. Sandals of Mayas, from statue in American Museum of Natural History. The feet were very square. Note similarity between this and Figure 4; probably leather.

FIG. 6. Japanese Zori of bast and cloth.

FIG. 7. Inca sandal reconstructed from foot of drinking cup shown by Mead—Inca Land.

The Japanese arrived at a different solution. They made use of the bast mats, but instead of the r-strap of the Egyptians they adopted a v-strap which spread from between the toes to either side of the sandal. These are called zori. (Fig. 6.)

The Incas,<sup>30</sup> judging from the foot of a cup that has been preserved, found the value of a waist strap across the foot rather than an interdigital thong as a retaining mechanism. This avoided the chafing effect of the thongs on moving parts. (Fig. 7.)

plant products. A related problem is concerned with blunting the effects of cold on the delicate dorsum of the foot and leg. So far as I know, this always happened beyond 40 degrees latitude and in high cold countries farther south, as Central Asia. As in the case of heat, so in the problems of cold the sufferer used the materials at hand. In parts where hair or fur-bearing animals existed, the simplest solution was to wrap the foot and leg in a piece of hide and bind it with a thong of fiber or leather. This was probably the

earliest solution of the problem of foot protection, and is the method still reverted to in dire want.

times the shoes were moccasin-like, sometimes almost boot-like. (Fig. 8.)

Fashions changed as man developed

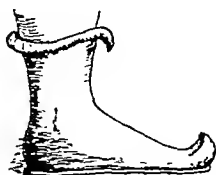


Fig. 8

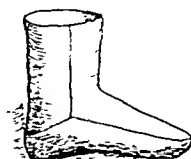


Fig. 9

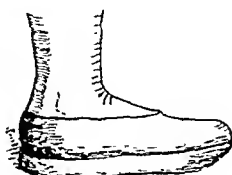


Fig. 10



Fig. 11



Fig. 12

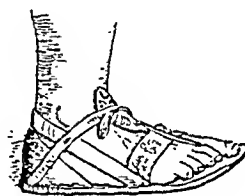


Fig. 13

FIG. 8. Shoe from sandals of Assyrian captives portrayed in several works; about 750 B.C.

FIG. 9. Felt (?) boot of Mongol Prince dated 1262 A.D. Shown by Martin. Note attempt to represent arch of foot.

FIG. 10. Chinese thick wooden soled shoe; contemporary for use in wet weather.

FIG. 11. European sabot.

FIG. 12. Japanese wooden geta for wet weather with tabi for warmth; contemporary.

FIG. 13. Greek sandal showing beginning of armoured tongue for foot protection. Shown by Gulick.

In mammalless New Zealand the Maori used indigenous basts to cover his feet, but I fear such material must have yielded a harsh, cold comfort.

The second phase in the development of the upper was the fashioning of the skin to the owner's foot and leg. This required the cutting and sewing of darts, the trimming away of excess leather, and the formation of loops for lacing, or the swaging of the wet leather to a mold. Such shoes or boots are represented on early Babylonian carvings of people from the north. Some-

new materials. Felts made before history begins were used early to form the footgear of the peoples of Central Asia and Europe. (Fig. 9.)

Weaving, too, antedates history, and the products of the loom were used betimes to form foot coverings. In some instances the cloth was used as skins had been before; the Chinese fastened cloth uppers to wooden soles at least 600 B.C.<sup>40</sup> (Fig. 10.) The cloth top was used in summer, leather tops in winter.<sup>26</sup> Another solution to the problem developed independently

in Western Europe and Japan. For indoor wear the cloth sock or hose sufficed, but in outdoor use the cloth quickly wore through. In Europe this led to the development of the galoshe, or pattern, a wooden sole with a cross strap for the ball and a quarter caught over the instep. These were slipped on and fastened over the cloth sock. The Japanese retained the thonged bast (*zori*) or wooden sandal (*getá*) and wore in addition a great-toe-stalled ankle height cloth shoe (*tabi*). The heavy sole could be put on or off by a mere flick of the toe. The degree of cold could be countered by altering the weight or character of the *tabi*.

The third basic problem concerned personal and possibly household cleanliness and dampness. The Chinese found the simplest but most weighty answer when they increased the thickness of their wooden soles, forming them into inverted and truncated pyramids which could be freed from the mud seal by a slight tug. A similar but less weighty solution was found in the European peasant's sabots, clogs and patterns, in which the sole was hollowed out under the instep. (Fig. 11.) The Japanese still further lightened the shoes for this purpose by reducing the piers to minimal size and weight, or by the use of cork soles. (Fig. 12.)

In Roman times elevated paths were built by the sides of the roads and properly placed stones permitted crossing from side to side without interfering with the movements of chariots and other vehicles. However, this refinement seems to have been neglected during the Dark and Middle Ages, and the term sidewalk does not appear in English until 1667, and in America until 1739;<sup>36</sup> since which time it has been a potent factor in the life of human feet. The building of sidewalks has formed a great social movement for dry feet and clean homes.

The final attack on the problem of moisture and mud was delivered from a new angle, the clothing of the feet with a light impenetrable pliable membrane. The

solution was conceived and perfected by Goodyear in 1839 when he developed the technic of vulcanizing rubber.<sup>11,12</sup>

Modifying protective requirements entered into the development of shoes. The darkness of Egypt presumably led to the same results as the modern blackout—broken toes. The toes of Egyptian sandals were frequently turned up as toe-guards. Upturned toes still characterize Levantine shoes.

The Greeks and Romans, judging by their protective measures (Fig. 13), seemed to be more in the habit of dropping things on their feet and hurting their shins, for the shoes of the fighting man of Rome frequently had incorporated into them a metallic toe-cap, or a tongue-like metallic guard on the dorsum of the foot that was frequently highly decorated. These shoes were spoken of as *caliga*. From them an ostentatious emperor received his nickname, "Caligula." The boxed toe of modern shoes and the steel capped industrial shoe would seem to stem from this ancient root.

Frequently the Polynesians<sup>4</sup> cut their feet on sharp coral, and these cuts are notoriously difficult to heal. Either the exigencies of life or their carefree zest for living led them to try to protect their injured feet so they could carry on. Their device was very ingenuous in that it prevented motions of the injured sole. They took a thick slab from the side of a coconut husk, passed a bast thong through a slot on the convex side, and tied it around the foot which rested on the flat surface. The injured man could now rock along without moving the injured part.

Vanity and disease, especially deformity, are frequently inseparable twins, Ovid remarking at the opening of this era, "Nor should an ill shaped foot be ever bare." We do not know why the Etruscan maid that modelled for the little statuette (600 B.C.), now in the Metropolitan Museum in New York, wore long pointed toes on her shoes, but tradition tells us that Count Fulk of Anjou (1100) tried to

hide his deformed feet in long pointed toed shoes. This camouflage (Fig. 14) was seized upon by his court, and one's

wedgies or heels is a subject that is rather confused. Kelly and Schwabe<sup>23</sup> state that "Heels in the modern sense were practi-

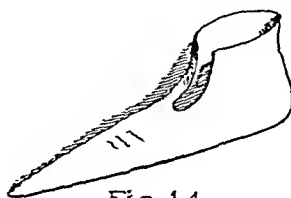


Fig. 14.

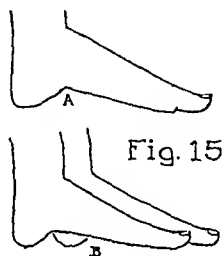


Fig. 15

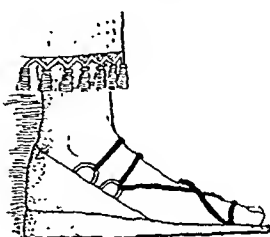


Fig. 16.



Fig 17.



Fig. 18.

FIG. 14. Long pointed toes; used from 1100-1500 A.D.

FIG. 15 A and B, feet from Plates VII and XXXV of breasted, showing representation of arch in barefooted individuals. Much like Figure 9. Note absence of small toes on near foot of B.

FIG. 16. Wedgie worn by Assur-nazir-apal about 850 B.C. Taken from bas-relief in Metropolitan Museum, New York.

FIG. 17. The heel of Timur, from a miniature dated 1467. Shown by Martin. The first true known heel in history.

FIG. 18. Shoe of the time of Henry VIII.

rank determined the length of his toes. Robert Cornard, a wag in the court of William Rufus, a contemporary of Fulk, pulled the toes of the French court, figuratively speaking, by converting the long toes into whales tails and curled rams horns. The length of toes fluctuated, finally necessitating the courtiers of Anne of Bohemia (1550) tying their toes to their knees. In England the whole problem of toes became so pointed that Edward IV (1442-1483) in his sumptuary laws cut all toes to a short two inches. The extremes have never come again; their pain-producing powers abide.

The raising of one's heels either on

cally unknown before 1600." Lester and Oerke<sup>28</sup> make a statement to the effect that the Cretans were the earliest users of heels. Both the statements, I believe, are in error, and I believe the history of heels is of more than ordinary interest. Evans<sup>13</sup> in his monumental work on the Palace of Minos at Knossos shows some primitive paintings of the human figure with the feet shaped as though they were fitted with heels. I believe the figures were unshod, for he elsewhere portrays shod feet. Breasted and Allen<sup>3</sup> in the folios of "Ancient Egyptian Paintings" show in Plate VII a fig picker dating from 1920-1900 B.C. with feet shaped the same way. (Fig. 15A.) The



figure is barefooted. Plate xxii shows "Two Cretan Tribute Bearers" in the time of Tuthmosis (1475-1448 B.C.) with a similar rendering; they, too, are unshod. Plate xxxv (Fig. 15B) depicts two seated figures partaking of the daily meal within the tomb. Their feet are placed one slightly in advance of the other, and the heel of the more distant foot shows through beneath the arch of the nearer foot. In short, the technic which Lester and Oerke thought was a heel is an attempt by the painters of that day to recognize the human arch, but their skill was not equal to the task. The shape of the foot reminds one of the Tartar's Boot dated 1262 A.D.<sup>29</sup> (Fig. 9.) I have seen the same technic used by the Egyptians to try to represent one person beyond another.

A bas-relief of Assur-nasir-apal iii (885-860 B.C.) (Fig. 16) in the Metropolitan Museum in New York represents this warrior king as shod with wedgies. Layard<sup>25</sup> shows a bas-relief with this king wearing wedgies while his attendants are flat soled. Assurbanipal (668-626 B.C.) likewise is represented as wearing wedgies.<sup>24</sup> Intervening monarchs are represented as wearing flat soles. These two wedgie wearers were the greatest warrior kings of Assyria. No trace of a true heel is found for twenty centuries till we come to the days of Timur. All pictures of mid-Asians from the eighth century onward show heelless boots and shoes. Timur, prior to the battle of Seistan, was simply known as Timur, but after that battle he had to retire to recover from wounds of his foot and hand. Thereafter he was Timur the lame or Tamerlane.<sup>24</sup> A miniature of him in 1467<sup>29</sup> shows him as wearing what is obviously a heeled boot. (Fig. 17.) In western Europe, as Kelly and Schwabe<sup>23</sup> state, "Heels in the modern sense were practically unknown before 1600."

Judging by others whose injured feet have received primitive care, it is not unreasonable to suppose that Timur developed a contracted heel cord. The putting of a heel under one foot would reduce

the pain of stretching, but would not affect the limp. The use of a heel under each foot would reduce the limp. The uniqueness of the heels would be hidden in a heeled court. This courtly method of covering royal defects is not unusual. Hanoverian George I could not pronounce Th except as T, and hence the old English Thāmes became Hanoverian Tems; neither could he change a Germanic ei (i) to the English ei (e) and hence English nēither became Germanic neither and ēither became either.

A century after Timur true heels began to appear in Western Europe. At first they were detachable objects of personal adornment. Later they became integral parts of the shoe but retained their decorative possibilities. Broad and low in the beginning, under Spanish and French influence they attained extreme heights, and the wearers teetered down the street spraining and breaking their ankles. The more stable and supportive "wedgies" returned for a time in the days of Elizabeth, only to reappear in our own day.<sup>7,9,14,19,23,27,28,33,39</sup> It seems to me probable that the heel is essentially a prosthesis for shortened heel cords, and that men and especially women are still paying unconscious tribute to the vanity of a wounded Tamerlane, or Assurnazir-apal.

These two raisings of the heel proper must be distinguished from the general elevations of the foot as we have seen in various mud shoes. In Europe this general heightening of the body stems from the cothurnus of the tragedians of Greece and Rome. Tertullian<sup>42</sup> speaks of this piece of footgear as the "lofty buskin, impiously striving to add a cubit" (18 inches). Obviously he could not be referring to a single posterior heel. This is borne out by the surviving statues of tragedians who trod the stage on cork blocks like children walk our streets on empty cans. From their use comes also our expression "high tragedy" as compared with "low comedy." Disappearing from the European scene for a long period these stiltlets reappeared by way of Baghdad during the Renaissance

as the Italian and French chopine—miniature coffee tables or ash stands—that raised the owner toward the Tertullian cubit which required two attendants for every wearer. These obviously issued from the vanity of a fingerling.

Henry VIII, the gluttonous playboy of English history, suffered from gout as well as a plethora of women. The long, low stuffed toes of Fulk would rest painful on Henry's knobby feet. This seems to have been the age of gout, for shoes had great square baggy toes. (Fig. 18.) The French, who had started the medieval rage for long toes, now sponsored the extremely broad square toes, and Lester<sup>27</sup> states that "one was not considered fashionable in France whose shoes did not measure a foot across the toes." Even England must have gone to an extreme, for Henry limited the width of toes to six inches. The square toed shoes of Henry were modified under the Stuarts and Cromwell, but the toes of Fulk and of Henry have remained in essence to this day, with a gradual resurgence of form-fit shoes.

Practically all shoes and sandals of Europe and Western Asia, except the long toed shoes of the Etruscans and those fashioned after Count Fulk and Henry the VIII, were shaped to rights and lefts. After them came a period when shoes apparently were unpaired. Not till the end of the nineteenth century did men again form shoes to individual feet.

The last major contribution was the installing of a metal shank to (1) preserve the shape of the shoe, (2) maintain the heel in position, (3) give the foot the support which had been removed by (a) the introduction of the heel, (b) the extension of sidewalks, (c) the more general and continuous use of the shoes. This, so far as I can determine, is a recent innovation dictated by necessity and not by royal whimsey, for the use of the word in this sense does not appear before 1875.<sup>36</sup>

The eternal primary requirement of footgear is for plantar protection; intrinsically of nearly equal importance is

the method of retaining the protective sole and giving warmth to the foot and leg, and that tertiary significance may apparently be assigned to other factors, as the shape, heel and shank; that the decorative factors are inconsequential except to the peace of mind of individuals who fit their clothing to their heads rather than bodies. However, from the standpoint of physiology the arrangement in importance of the elements may be very different.

#### PHYSIOLOGY OF THE SHOD FOOT

The third part of our problem is concerned with the physiological effects of the several parts of our footgear on the foot.

In studying soles we shall consider heelless sandals hypotheating an adequate method of retention which will in no way interfere with foot physiology. From this standpoint a *fully flexible sole* would seem to be ideal, provided it afforded adequate plantar protection. In reality it is used either out-of-doors to provide additional protection to already hardened feet, as by the Indian, or indoors as a slight protection to tender feet, as in the house-slipper. The Indian would not deign to wear them on our polished floors, while tender feet with them would be wrecked on the rocky mesas of Arizona.

The *semi-flexible sole* affords much greater protection to the wearer and only prevents plantar flexion of the toes. This adaptive or primary prehensile phase of toe activity would no longer be so essential. This is the common sole of men's shoes.

The *inflexible sole* may be either (1) flat (Fig. 2), as in the sandals of Wah, or (2) moulded, as in the ordinary pattern. Either would prevent not only the primary but also the secondary prehensile phases of toe activity, and would permit normal physiology only in the static stage. The flat inflexible sole would throw all flexion and extension into the ankle joint, causing a very awkward gait. The moulded inflexible sole would tend to overcome this difficulty, but its roll is hard to control, as one sees in pattern wearers.

The interdigital thongs of Egypt, Polynesia, or Japan would cause no interference with any form of foot physiology. The quarter, either closed as in Babylonia or open as in Polynesia, would have little if any effect on normal foot physiology. The upper which binds the foot to the sole, has a much greater influence. Let us presume a flat rigid sole such as the sandals of Wah. As it was constructed originally, as Wah passed from the static stage the heel loop of pliable material permitted the heel to rise a variable distance, giving him at least a modicum of the normal passive dorsiflexion of the toes. On the other hand, if this shoe had been constructed with a complete upper, as in the case of clogs, the wearer would have to lift his foot directly from the ground at every step; there would be no rolling from one phase of the step to another. The use of a semi-flexible sole, however, would permit the normal fourth or push-off stage, even with a complete upper, provided it approximates the shape of the foot, i.e., with a straight inner edge and an oblique lateral side and an anterior border paralleling the toes. The making of shoes to the shape of the wearer's foot was largely a function of the ancient shoemaker as distinguished from the cobbler (Tables from Tolstoi) or butcher. The introduction of machinery standardized lengths, widths, shapes, etc. The fallacy of this method is reflected in a great measure by foot discomfort, but may be seen in any open heeled shoe in which a certain number of people are seen whose heel projects usually far to the inner side beyond the top of the heel, indicating a varus element in a certain proportion of normal feet.

Other factors, such as chafing, might be the critical one. Whether the shoes were high or low might depend on their proposed use or the climate. However, the upper, regardless of the type of sole, must be large enough or elastic enough to permit the slight static spread of the third or postural stage of foot physiology. From the standpoint of adequate easy retention

and maximal physiological activity of the foot, the ideal was probably attained either in the sandal of the Incas, in which retention occurred in non-moving parts (Fig. 7), or by the Japanese use of the stalled tabi with the zori. (Fig. 6.) I have never known or found any doctor who has ever had a zori wearer complaining of foot difficulty.

*The method of fastening the upper is of passing interest.* Thongs antedate history. Buttons were used on shoes in Cyprus in the sixth and seventh centuries B.C. (Metropolitan Museum, New York.) Buckles or fibulae date at least from Roman times. Hooks and eyes are used on tabis, but I do not know their age. Elastic inserts are less than a century old, and zippers less than a decade. These have no intrinsic effect on foot physiology.

One should remember that the heel is essentially a prosthesis for a deformity. Too many writers assume that heels—any heels—are an essential part of a shoe; few if any ever approach the heel analytically from the standpoint of physiology. What is the effect of the heel on normal foot physiology?

1. The muscles of the non-weight bearing foot appear to be toneless. The instant weight is borne on the foot, one may feel reflex or postural tone develop in the abductors hallucis and minimi digiti, and in the adductor hallucis and to a lesser degree in the other plantar muscles. The insertion of a heel even as low as that of the average man's shoe causes a decrease in the tone of these postural muscles by about a half, and there develops a slight increase in the tension on the plantar fascia. The use of a two or three inch heel completely relieves the intrinsic postural muscles of the foot of their tone, and markedly increases tension in the plantar fascia; i.e., the postural reflex mechanism of the foot is negated by heels, and passive tension on non-contractile fascia is substituted for muscle tone. When one considers the fact that many individuals never go unshod, and that even their

bedroom slippers are heeled, one can then appreciate the fact that the postural use of the muscles of the foot are rarely if ever used, and they are constantly straining on tissue with an essentially different physiology. It is not surprising, then, that foot complaints are infinitely more common among women.

2. The introduction of a heel shortens the leverage of the foot for propulsion. A woman's foot that measures 6 inches from heel to ball on the level becomes 5 inches long in a  $2\frac{3}{4}$  inch heel and 4 inches long in a  $3\frac{1}{2}$  inch heel. This decrease in leverage would tend to increase the muscular effort required in the push-off, or it would reduce the effectiveness of the gait.

3. The introduction of any heel decreases the postural power of the erectors of the tibia. The proprioceptive reflexes on which muscle tone or postural activity depends is stimulated by stretching. The elevation of the heel either relaxes the tendo Achilles or it causes the wearer to walk with knees that droop forward in proportion to the height of the heel. If persisted in, a structural shortening of the tendo Achilles occurs that makes a return to lower heels distinctly painful. The drooping of the knee causes a relaxation of the hamstrings which are the postural stabilizers of the knee and pelvis, and so the whole postural mechanism is upset.

4. The toes are kept in more or less complete dorsiflexion, i.e., in the propellor position, and get little if any opportunity to change their positions. In the extremely high heels the tendency is for the lumbricales to be thrown out almost completely, and the longer flexors draw the toes into the position of hammer toes by tendon action. Furthermore, their retention in this position almost without change tends to the formation of capsular shortenings and other structural changes that cause pain when put under tension.

5. The higher the heel the more the toes are dorsiflexed, the more weight is

thrown on the articular surfaces of the metatarsal heads, especially of the slender middle metatarsals which are essentially non-weight-bearing structures.

6. The toes as they are dorsiflexed tend to spread apart, so that the higher the heel the broader the toes should be, but in practice the higher the heel the more pointed is the toe. Thus the strain is doubled.

Thus it appears that heels from the physiological standpoint are of primary rather than tertiary importance, being the most destructive factor in foot physiology.

What then are the suggestions offered for the problem of foot protection?

1. Plantar protection may be offered in the form of semi-flexible soles for harsher wear, and fully flexible soles for lighter wear, but best of all for all ages would be the use of the unshod foot except where the going was rough, dangerous or painful.

2. If plantar protection is needed, it should be retained by a structure that interferes the least with foot activity and physiology, and yielding such protection against the weather or other dangers, as falling cargo or steel plate, as would be necessary to the protection of the foot; i.e., toe caps should be solid enough to prevent crushing, but high enough to permit unrestricted toe activity. The use of a fully flexible protection against the weather and a separate article of clothing for plantar protection, as the Japanese do, would seem to be rather the ideal, although I am not committed to the wearing of the zori, but would incline rather to the footgear of the Incas. (Fig. 7.)

3. Heels should be omitted altogether as utterly destructive of normal foot physiology, and the sole of the shoe should be moulded to the foot for adequate and normal support that is not yielded by a flat formless sole.

4. The sandals of Tutankhamen (Fig. 1) should delight the heart of any woman or the man she baits. Others have been and could be built of equal or greater beauty.

5. The shoes should be built to the individual foot. This should not be so difficult a task with plastics as with present leather and cloth shoes.

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## Editorial

### TALCUM POWDER—A GRAVE SURGICAL HAZARD

**A**PPROXIMATELY two-thirds of a century has elapsed since the surgical world first learned of the dangers incident to the use of insoluble dusting powders; and yet surgeons have proceeded merrily in the use of these harmful substances. The reason for this seeming unconcern is not far to seek and lies in the fact that up to fairly recent times, dusting powders were used comparatively occasionally. With the advent of the use of dry gloves, talcum came into much more general use. It has been estimated that 1,000,000 pounds of it are used yearly in the United States.

The dusting powder most commonly used in surgery is talcum, a mixture of elements consisting largely of magnesium silicate. In the past, lycopodium, derived from the spores of club moss, was much more commonly used than it is today. The important factors involved in the use of both these substances is their almost complete insolubility, their tendency to set up a reactionary inflammation in whatever body tissues they find lodgment, and the consequent development of inflammatory granulomas leading to ultimate fibrosis. Such a process, set up in the peritoneal cavity, results, almost inevitably, in the development of adhesions of a firm and resisting type that, in some cases, leads to eventual intestinal obstruction. Viewed

both grossly and microscopically the lesions caused by talcum may create much confusion and uncertainty. Grossly the similarity to tuberculosis may be most baffling and not infrequently the resultant granulomas are confused with malignant growths.

Nor is the peritoneal cavity the only region in mammalian anatomy that is compromised by the effects of contact with talcum powder. The brain, uterus, rectum, cervix uteri, eye, muscle, connective tissues, healing wounds and possibly other organs and tissues show equally unfavorable reactions. It has been suggested by Kronenberg that the preparation of rubber gloves with talcum, by nurses, for surgical use, be construed as a hazardous occupation and that the State of Illinois authorities take steps to control and remove the danger.

Such being the facts, we are confronted with the unusual situation that surgeons nevertheless have persisted in continuing the use of such a vicious substance as talcum powder. There has been no lack of discussion of the topic, as will be appreciated by a glance at the bibliographic references appended to the recent article by Seelig, Verda and Kidd, in the Journal of the American Medical Association for December 11, 1943. These authors outline in detail the history of this chapter in

surgery and furnish additional surgical proof of the pressing necessity for the issuance by the surgical fraternity of a "cease and desist" order that will ban talcum powder from operating rooms, wards, dressing rooms and dispensaries. Their work seems to rest on a very solid foundation of experimental data, well supporting the plea for discontinuing such a universal irritant as are the insoluble dusting powders.

It seems to be fatuous to hope that through team work, or through the practice of any reasonable precautionary measures, the evils of talcum may be side tracked. It is practically impossible to rinse it off the surface of rubber gloves and it is almost equally impossible to prevent an excess of talcum from gravitating into the finger tips of the gloves. Very careful studies have shown that gloves are inevitably torn in approximately 75 per cent of all operations, and that approximately 25 per cent of all gloves used show rents or tears.

A most interesting fact that bears on the detection of talcum in the tissues has been emphasized by German, of Cincinnati, who showed that by examining sections under polarized light the highly refractal talc crystals are detected very readily. Under ordinary illumination, these crystals may

be very elusive. German was able to show that talcum crystals were present in 84 per cent of the abdominal cavities of a series of patients who had been subjected to laparotomy.

Seelig and his co-workers have found that potassium bitartrate, properly used, serves as a fairly satisfactory substitute for talcum and they furnish their reasons for this recommendation. Reading between the lines of their first contribution to the subject, one gathers that the problem is not yet solved with complete satisfaction; but that the search has not yet ended. Studies are continuing with a specially prepared starch. This new starch does not gel on boiling or autoclaving, is ideal in its physical properties, and is attacked by the diastase in the body fluids with such astounding rapidity that within a few hours it is completely absorbed from the body cavities and from the body tissues. More important than all this is the fact that it is a bland powder that the body tolerates with no perceptible tissue reaction. This powder is not yet on the market because of manufacturing restrictions imposed by the war. But the scene is all set for the final undoing of talcum, with the consequent release of surgeons from fear of postoperative complications due to its use.

M. G. S.



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## Editorial

### SURGERY AND THE SURGICAL SPECIALTIES IN A CHANGING WORLD\*

THE most important task before the nation today is the winning of the war. The war is not yet won; much remains to be done before victory rewards the magnificent efforts of our armed forces.

Unfortunately our recent victories, with the all too prevalent talk of reconversion and post-war planning, have led to a great relaxation of effort on the part of many of our citizens who believe that the war has been won.

The war activities of the medical profession continue without surcease or change, both in the armed forces and on the home front. All resources are being fully utilized and often under great handicaps. Nevertheless, the health of our troops is the best of any army in the world. Battle casualties are receiving the best surgical care possible. In World War I battle casualties operated upon in evacuation hospitals had a mortality of about 14 to 16 per cent, whereas in this war they are 2 per cent. The health of the civilian population is the best in our history, even with more than 58,000 physicians in the armed forces. It is incumbent upon all of us not only to acquaint the public of these facts but to tell them how they came about.

These outstanding results are due to the splendid medical education received by

these young men before they entered the war and also due to the fact that they are in the front lines administering aid right at the place of injury. The public is too prone to ascribe these medical achievements to new miracle drugs alone, and to lose sight of the fact that they are due to the work of the physicians.

Never before has there been a conflict of such magnitude, as far as the number of men and women engaged in the war, the global extent of the fighting fronts, the mechanization of war, the speed of war movement, and the rapid evacuation of sick and injured by air transport.

The percussions and repercussions of any war are always in direct ratio to the extent and intensity of hostilities. It behooves all of us to consider the reverberations that will certainly occur after hostilities cease. This war surpasses in every way World War I, therefore, it is reasonable to assume that subsequent social, political, and economic problems will be that much greater.

For many years certain pressure groups have promoted propaganda to revolutionize the type of medical practice in this country. Most of this propaganda is the work of social workers, statisticians, and economists who know little or nothing about the care of the sick. The present high

\* Read at the Annual Meeting of the Western Surgical Association held in Chicago, December 1 and 2, 1944.



status of efficiency of medical service in this country is definitely related to our present system of practice.

The medical profession is not static. The American Medical Association, through its constituent state and county medical societies, has sponsored various plans to meet the costs of medical care. Their prime concern was to insure the best care for the patient. We are the most completely insured nation in the world with 68,000,000 policy holders for life insurance. Just as we have been educated to buy insurance against all sorts of hazards, so, too, the public can be educated to purchase health and hospital insurance. Indeed already more than 18,000,000 workers are now insured in whole or in part against some of the hazards of illness. The privilege to do this is the privilege of the citizen. There is no proof that he can't or won't, nor is there any proof that government with its ever increasing taxes and bureaucracy can do it better.

The American Medical Association, in connection with the American College of Surgeons and the American College of Physicians, realizing the need to meet problems after the war, established the Committee on Post-War Medical Service.

The problem of first concern was medical education. With a shortened internship, with the interruption of the training of the resident and the research worker, a study of the needs of the returning medical officers was undertaken through the Council on Medical Education and Hospitals of the American Medical Association. This problem concerned the educational facilities required for returning medical officers and the future educational objectives of medical officers. These studies were carried out by Dr. Victor Johnson and Dr. F. S. Arested of the Council and by Lt. Col. Harold C. Lueth, A.U.S. Surgeon General's Liaison officer.

The tabulations of 11,019 questionnaires showed that 58.2 per cent favored or desired to take long courses, 23.4 per cent short courses, and 18.4 per cent desired no addi-

tional training. Interesting is the fact that the largest number of men requesting long courses came from the recent graduates; 3,640 requests out of a total of 6,417 came from men who graduated from 1938 to 1943. The large number of requests for short courses came from the older graduates, men who graduated before 1920 and from 1920 to 1929.

Marked expansion of educational facilities will be required, temporarily, to meet the needs of the returning medical officers. This responsibility rests with the medical profession, the medical schools and the hospitals of the United States.

There probably will be other programs, such as giving courses to the medical officers while still in service.

The need for teachers is obvious, if this new program is to be carried out. Hence, in demobilization some thought and consideration must be given to the teachers who are to carry out these teaching programs.

The Council is making a survey of present facilities, their expansion and possibility of new facilities.

Anticipating some of the problems of the returning medical officers, the House of Delegates of the American Medical Association at its annual session in Chicago, 1944, authorized the establishment of a Bureau of Information. Specifically, the aims of this Bureau are to provide the veteran medical officers information concerning educational opportunities; to provide him with information concerning state licensure and facilitating their procurement of licensure in states other than the state of former practice. In addition, the Bureau will provide the medical officer with information concerning medical, social, economic and other phases of community life so as to enable him to make a wise selection of his permanent location in which to practice. It is difficult at this time to state how many returning officers may wish to change their location. Certainly it will be of great value to the young man about to establish a practice.

Already Congress has provided for the education of the veteran and authorities have ruled that returning medical veterans may receive from one to three years of such education with an allowance of \$500.00 annually for tuition which may be paid to the hospital that provides a residency and \$75.00 a month for subsistence.

Although a few of the certifying boards were established before 1933, the great impetus to graduate medical education in this country followed the action of the House of Delegates of the American Medical Association, when by resolution at the annual session in 1933 they instructed the Council of Medical Education and Hospitals to set up standards for graduate medical education and to aid in the establishment of certifying boards.

Not only have the boards set up standards for training in the various specialties but they have taken steps to make facilities available for training men who wish to take the examinations. The boards were established on a voluntary basis by the profession for the purpose of improving the quality of medical care to be given to the people. As in any new undertaking there are apt to be certain pitfalls and errors, I think on the whole the various boards have avoided these pitfalls. Some of the boards, I am afraid, have lost sight of the original function of the boards, namely, to certify men who are competent in their specialty. There seems to be a tendency to lengthen the period of training by some boards and to insist that the candidate present evidence of research activities.

I disagree with the statement that a specialist necessarily has a limited point of view and that because he confines his work he fails to consider the patient as a whole. If this is general, then does not the fault lie with those of us engaged in teaching? In order to avoid these pitfalls the American Board of Urology includes in its examinations questions on surgical principles such as inflammation, wound repair, shock and hemorrhage, etc. We believe the urologist should be familiar with the diagnosis

of surgical complications, hence include such subjects as pneumonia, pulmonary embolism, atelectasis, postoperative dilatation of the stomach, etc.

With the return of the medical officer who has not completed his requirements, a special problem exists when he presents himself for his final examination.

The boards will assume in the postwar period not only a very important place in the training of the returning medical officers, but also in the guidance of the younger men whose training has been interrupted by the war.

Whether or not we practice a surgical specialty, and I include general surgery as a specialty, the need for a broad training in the fundamentals is necessary. This is basic at the undergraduate level. I am afraid that this is often sadly neglected. I believe that in the postwar period we must have another look at our system of teaching at the undergraduate level.

I am amazed at the number of interns who have no conception of writing a good history, and of their inability to carry out a good physical examination. It is evident that the teaching of these subjects needs a new appraisal. The ease with which the history and physical examination are glossed over and the rapidity with which they reach for laboratory aids is astounding. At times one wonders whether the present day clinician has lost his powers of observation and teaching. The overemphasis on the laboratory side, rather than the clinical side, is striking. The fear to make a diagnosis of acute appendicitis without a blood count, the hesitation to make a diagnosis of renal stone because the x-ray is negative, the timidity to make a diagnosis of a Potts' or Colles' fracture because no x-ray is available, all cause one to wonder. The case of tabes with cardinal signs receives no diagnosis until the Wassermann report is at hand.

Is it possible that the pendulum has swung too far? I believe we should teach our young men to make a diagnosis without resorting to all sorts of tests and then to

verify the diagnosis with the laboratory tests indicated. History taking seems to be almost a lost art as is physical diagnosis.

Whether one practises general surgery or one of the surgical specialties one must look at the patient as a whole. This means that each patient should be viewed as a medical problem first, one who may require some type of surgical treatment.

Many operations formerly so common in every clinic have practically disappeared. No longer are the wards filled with cases of surgical tuberculosis, such as extensive involvement of the glands of the neck, bone and joint involvement and genitourinary tuberculosis. "Pus tubes," formerly on every operative clinic schedule, are almost forgotten. Internal and external urethrotomy for urethral strictures following gonorrhea are a thing of the past. The number of goiter operations are markedly on the decrease.

On the other hand new surgical fields of endeavor have been developed, our knowledge increased, and the patient the recipient of better and wider surgical care. The outstanding achievements in the fields of neurosurgery, orthopedic surgery, genitourinary surgery, and chest surgery are phenomenal.

The recent developments in the field of endocrine surgery and vascular surgery, while just at the brink of development, bid to further expansion. The work of the gynecologist in endometriosis has been most significant.

With our increased knowledge of pathology and with improvements in technical equipment, revolutionary changes have occurred in treatment. Conditions formerly treated by major surgical procedures have given way to simpler procedures which have reduced both mortality and morbidity. I will refer to only two of them—the treatment of papillomas of the bladder, large and small as well as borderline in

malignancy, by fulguration through the cystoscope, and the treatment of benign prostatic obstruction by resection which has almost completely replaced prostatectomy.

The practice of medicine tends more and more toward preventive medicine. The surgeon and the surgical specialist also practise preventive surgery.

The importance of preoperative preparation of the patient first stressed by the urologist, the preliminary administration of iodine to the goiter patient, the choice of one of many forms of anesthesia, the preoperative transfusion of blood, the use of sulfa drugs in the abdominal cavity to prevent peritonitis, and the use of sulfa drugs and penicillin before the extraction of infected teeth certainly constitute preventive measures.

The value of the blood bank established itself in short order. The life saving feats of the blood banks soon led to the establishment of the eye bank, the bank for dehydrated nerves and the cartilage bank. The use of frozen sections of veins in the African campaign will no doubt lead to the establishment of banks for frozen veins.

What will be the impact of all this on the future practice of surgery? Following the last war, and in part due to it, great impetus was given to group practice. The Western Surgical Association was founded by individual practitioners of surgery and the surgical specialties. With the large number of group clinics, with university medical schools engaged in private and semi-private practice of medicine, with industry entering the field of prevention of industrial diseases and accidents, but also a tendency to engage in practice, we may well pause to reflect on the future position of the individual surgeon and surgical specialist.

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# Original Articles

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## TREATMENT OF ABDOMINAL INJURIES\*

### REVIEW OF EIGHTY-EIGHT PERSONAL CASES

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THE present war has created widespread interest in the emergency treatment of acute abdominal injuries. Kirk<sup>70</sup> states that, "although abdominal wounds comprise a relatively small number of all war wounds, they are particularly important because they contribute most to the case fatality rate." In former wars, many seriously injured patients were considered hopeless and it was thought that the time consumed in their management would be better spent in the treatment of injuries with more favorable prognoses. At the present time, however, the outlook is more favorable, because of the efficient methods of transportation and the creation of special surgical units to care for this type of injury.<sup>122</sup>

The scope of this paper includes, in chronological sequence, the emergency treatment of acute abdominal injuries from the time of admission to the emergency room until the danger of post-operative complications is past and the condition becomes one of routine convalescent care. A brief review of eighty-eight personal cases is presented.

*Case Classification and Early Treatment of Shock.* Patients admitted to the emergency room must be classified primarily as those in shock or impending shock and those not in shock. If shock or impending

shock is present, then its treatment should be the first consideration. Morphine should be administered in large doses (from  $\frac{1}{4}$  to  $\frac{1}{2}$  gr. subcutaneously depending on the size and age of the patient) to alleviate pain and apprehension. When severe pain is a factor in the production of shock, smaller doses of morphine (usually  $\frac{1}{6}$  gr.) may be slowly administered intravenously. If evisceration is present, the exposed organs should be wrapped in sterile towels moistened with warm saline solution and a temporary dressing applied until the patient reaches the operating room. In the absence of head or chest injuries, the foot of the bed should be elevated twelve inches to help prevent cerebral anemia,<sup>19,31</sup> and increase the return blood flow to the heart.<sup>101</sup> Five per cent glucose in normal saline should be started immediately.<sup>31</sup> Plasma<sup>18, 19, 60, 61, 69, 108</sup> or blood<sup>5, 60, 61</sup> may then be administered as indicated. It is our policy to use a DeBakey needle of the donor type or a No. 19 gauge needle and start with 5 per cent glucose in normal saline, then change to plasma if the patient is suffering from shock without hemorrhage or change to plasma until compatible blood can be obtained when excessive blood loss is the major factor. Adrenal cortical hormone, 75 to 100 dog units intravenously, has been found to be of value by some investigators.<sup>9</sup> Its efficacy,

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however, has been disputed.<sup>4,19</sup> There is some controversy about the use of heat in shock.<sup>6</sup> Whereas the application of heat has been advocated in the past, it is now known that over-warming is actually detrimental in shock because it favors vasodilatation and excessive loss of fluid through perspiration.<sup>20</sup> Although excessive warming is undesirable, prevention of chilling is imperative. For this reason the covering with blankets of a patient in shock is desirable. The use of cold in shock is advocated by some investigators,<sup>6</sup> but we have had no experience with such treatment. The patient's pulse rate and blood pressure should be recorded at least every fifteen minutes. Oxygen should be administered by nasal catheter or B.L.B. mask to prevent anoxemia. It is a known fact that shock may produce anoxemia which, in turn, increases capillary permeability with resultant vasomotor collapse,<sup>60</sup> thus establishing a vicious cycle.<sup>21</sup>

Response to the treatment of shock should determine the time for exploratory laparotomy. The patients may be divided into three types: First, those who respond well to the shock treatment, that is, pulse rate and blood pressure become stabilized and remain so for a period of one to two hours. These patients may then be operated upon if exploration is indicated. Second, those patients responding adequately to the treatment of shock for a short period of time only, subsequently relapsing into their original state. These patients usually have profuse intra-abdominal hemorrhage and operation should be performed at once to control the bleeding, following which further transfusion will be beneficial.<sup>7,73</sup> Third, those patients who do not respond to adequate shock therapy, but continue in profound collapse; they are usually hopeless and operation may serve only to hasten the lethal exitus, unless there is a remote possibility of controlling massive hemorrhage.<sup>127</sup> Obviously, the deciding factor then becomes the surgical judgment of the physician,<sup>74</sup> and

occasionally death can be prevented by heroic surgery.

*Aids in Diagnosis.* While the patient is being treated for shock, certain laboratory and diagnostic procedures are indicated. The most effective means of estimating the amount of blood loss is the serum protein determination by the falling drop method of Barbour and Hamilton<sup>12</sup> together with repeated hematocrit readings.<sup>15,82</sup> These methods show exact blood changes twenty-five times more accurately than the older system of frequent blood counts and hemoglobin estimations. When the specific gravity of peripheral blood increases, water loss is present; conversely, when the specific gravity decreases, hemorrhage is present. It can be determined from this procedure whether the bleeding is progressing, decreasing or remaining static, thus simplifying the diagnosis and therapy.<sup>8,9</sup> The red blood count and hemoglobin determination may serve as indications of the presence of shock or hemorrhage, but are not as accurate as the method previously mentioned. The leucocyte count is usually not helpful.<sup>114</sup> A voided or catheterized specimen of urine should be examined for gross or microscopic blood to determine the presence of injury to the genitourinary tract.<sup>11,84,120</sup> If hematuria is present, injury to the bladder may be determined by insertion of a catheter and installation of sodium iodide, followed by roentgenograms.<sup>104</sup> When possible, the patient should be cystoscoped. A rectal examination should be done to determine the presence of blood in the lower gastrointestinal tract.

Roentgenograms are of diagnostic value in perforating wounds of the abdomen,<sup>53,114</sup> because of the frequency of free gas within the peritoneum when a hollow viscus is injured.<sup>104</sup> However, manipulation of the patient is a dangerous procedure and may cause relapse into shock.<sup>17,24</sup> If there is a point of entrance and none of exit, the roentgenogram is valuable also in locating the site of the foreign body.<sup>50,97</sup> If the patient is not in shock, an anteroposterior

roentgenogram with the patient in the erect position is desirable; in the presence of shock an anteroposterior film with the patient in the left lateral decubitus is preferable. In the latter view air under the right costal margin between the liver and the chest wall is visible. It should be remembered, however, that failure to find air under the diaphragm does not preclude the possibility of injury to a hollow viscus, as a perforation may produce free air either relatively late or not at all.<sup>38</sup> Pneumoperitoneum usually indicates injury either to the stomach or to the gas-filled colon.<sup>112</sup> If the patient's condition permits, fluoroscopy is of definite value in locating the foreign body. When this method is used the position of the patient can be changed and site of the foreign body marked on the skin.<sup>106</sup>

We have found peritoneal aspiration to be helpful in questionable cases of non-penetrating intra-abdominal injuries. A No. 18 gauge spinal needle is inserted over the probable site of the injury. The aspiration of gross blood or fecally contaminated peritoneal fluid verifies the diagnosis of a ruptured viscus.<sup>56,64</sup> Negative findings in one area, however, do not preclude positive results at another point.

*Patients Not Requiring Operation.* Laparotomy is usually not indicated under the following conditions: (1) When shock is controlled and the injury localized to the substance of the liver, with no possibility of injury to the gallbladder or extrahepatic biliary system. Bleeding from the liver *per se* usually responds to conservative measures and packing or suturing of the liver is only rarely necessary.<sup>102</sup> (2) In non-penetrating wounds confined to the abdominal wall, when trauma from a blunt object has not played a major rôle. (3) In wounds of the abdomen made with a small sharp instrument, such as an ice-pick, or when injury is due to multiple bird-shot wounds. Even if the bowel has been perforated in this manner, usually the wounds are so small that the serosa seals over without leakage and only careful

observation with conservative therapy is indicated.<sup>10,41,135</sup> (4) In patients whose injuries are of long duration and anatomical or functional restitution is obviously impossible.

The preceding conditions have been listed as injuries usually not requiring laparotomy, but whenever there is reasonable doubt an exploratory operative procedure should be resorted to.<sup>44,71,84,93,110,113,136</sup>

*Patients Definitely Requiring Operation.* In the following conditions exploratory laparotomy is indicated: (1) In continued shock for one or one and one-half hours despite adequate shock therapy and blood transfusions, because continued intra-abdominal hemorrhage is usually present and will obviously continue unless bleeding is controlled and transfusions administered. (2) Torn abdominal wall with lacerated gut or omentum protruding into the site of the wound.<sup>62</sup> (3) Where there is definite evidence of a perforation of a hollow viscus as suggested by vomiting of blood, signs of peritonitis or bloody stools. (4) Increasing abdominal pain and rigidity. (5) Air under the diaphragm, revealed by roentgenologic examination. (6) An increasing pulse rate together with questionable evidence of intra-abdominal injury.<sup>102</sup> (7) Although the treatment of kidney injuries is usually conservative,<sup>36,106</sup> operation is indicated if there is evidence of excessive retroperitoneal hemorrhage manifested by bulging of the flank with increasing shock, pain and hematuria.<sup>32,37</sup> (8) Injury to the bladder determined by hematuria, cystography or cystoscopy.

*Pre-anesthetic preparation.* When laparotomy is necessary, the preoperative basal anesthetic must be considered. Scopolamine or atropine may be used, but scopolamine is the drug of choice, administered in the ratio of  $\frac{1}{100}$  gr. to  $\frac{1}{4}$  gr. of morphine,  $\frac{1}{150}$  gr. to  $\frac{1}{6}$  gr. of morphine, etc., the exact dose depending on the size and age of the patient. Scopolamine is believed to be more effective than atropine because of its pronounced synergistic effect with morphine in depressing the

cerebral cortex and a more profound amnesia, while, at the same time, it tends to counteract the depressing effects of morphine upon the respiratory center. In the past, toxic reactions from the use of scopolamine because of its impurity were common and the drug fell into disuse. At the present time, however, the pure drug is obtainable and may be used without hesitancy. It has been thought by some that scopolamine has a depressing effect upon the respiratory center, but more recent pharmacologic studies have disproved this.<sup>1</sup>

The prompt administration of anti-tetanic and antigen sera is essential, and should be done shortly after the patient has been given the preoperative basal anesthetic. By this time, sedation has taken effect and there is less likelihood of shock or allergic reaction. Three thousand units of tetanus anti-toxin should be administered following a negative sensitivity test. If toxoid has been given previously, a booster dose should be administered.<sup>41</sup> In the presence of seriously contaminated wounds it is advisable to administer polyvalent gas bacillus anti-toxin.<sup>7,137</sup>

*Selection of Anesthetic.* Consideration of the problem of the selection of the anesthetic is most important, but detailed discussion of this phase is beyond the scope of this paper. The maintenance of quiet respiration, high oxygenation and complete abdominal relaxation with rapid return to consciousness following completion of the operation is, of course, necessary. Obviously, highly trained anesthetists are always desirable but not always available. Therefore, in order of preference, the following anesthetic agents will be considered.<sup>71,73</sup> (1) Gas (ethylene) induction followed by ether and oxygen<sup>76</sup> allows a high oxygen concentration in the blood, as only 4 per cent concentration of ether in the alveoli is required to produce total anesthesia and complete relaxation. Theoretically, this allows an alveolar concentration as high as 90 per cent oxygen, 4 per cent ether, and 5 per cent carbon dioxide.

It should be kept in mind that ethylene, ether and cyclopropane are inflammable. (2) Cyclopropane and oxygen also allow a high concentration of oxygen and complete relaxation. The alveolar concentration for surgical anesthesia is 20 to 25 per cent cyclopropane and 60 to 70 per cent oxygen. (3) A spinal anesthetic fulfills all of the requirements in regard to complete relaxation but should not be used in the presence of shock,<sup>48,51,116,139</sup> as it usually produces a further fall in blood pressure. If, however, the blood pressure is stabilized and there is no evidence of shock or impending shock, a spinal anesthetic may be used. Ephedrine sulfate should always be administered at the time the lumbar puncture is made and this dosage may be supplemented by intravenous injections if a fall in blood pressure ensues. It should be remembered that spinal anesthesia paralyzes the splanchnic vessels, destroying the compensatory mechanism of the splanchnic bed which is so valuable in shock. (4) Nitrous oxide is a dangerous drug in the hands of the inexperienced. It is necessary to have approximately 80 to 85 per cent concentration of nitrous oxide in the alveoli, allowing only 10 to 15 per cent of oxygen, before anesthesia can be produced. This high concentration borders on anoxemia and is extremely undesirable in patients suffering from shock or impending shock. Poor relaxation is usually obtained and asphyxia sometimes occurs when an effort is made to push the anesthetic for further relaxation. (5) Pentothal is not an anesthetic of choice, as it frequently causes laryngeal spasm, depression of respiration with ensuing anoxemia and does not produce complete relaxation.<sup>1</sup> When shock is present the depth of anesthesia is difficult to control and the recovery period is often prolonged.<sup>1</sup> When pentothal is used, oxygen by mask should be administered throughout the procedure. The armed forces have found pentothal useful because of its non-inflammable nature and ease of administration. In an analysis of 7,500 cases of anesthesia



overseas the death rate attributable to pentothal was found to be six times higher than the death rate from all other anesthetic agents combined.<sup>96</sup> It is not to be recommended where more satisfactory anesthetics are available. (6) While local anesthetics do not produce the relaxation needed for an exploratory laparotomy, they may be satisfactory in certain instances when supplemented by a light gas anesthetic. A local anesthetic may be used for small, superficial, non-penetrating wounds.

*Choice of Incision.* The choice of incision is determined by the site of the injury and the course of the trauma.<sup>74,118</sup> The paramedian incision gives greater exposure and may be extended either above or below the umbilicus.<sup>51,52</sup> The incision may be made either to the right or left of the midline or with the "L" or "T" shaped extension<sup>79</sup> as the case may warrant. The transverse incision is recommended by some authors and is indicated when maximum exposure of certain organs, such as the spleen, etc., is desired. The individual case must be considered and no empirical rule can be followed.<sup>74</sup> However, in our experience the longitudinal incision permits better general exploration of the abdomen.

*Technic of Operation.* The sites of the entrance and exit wounds should be thoroughly scrubbed with soap and water for ten minutes. If evisceration is present, lacerations of the gut should be sutured, the bowel irrigated with copious amounts of warm saline solution, gently sponged with cotton balls and returned to the abdominal cavity. The surgical team should then change gloves and gowns and a thorough débridement should be performed, followed by closure of the penetrating abdominal wound.

A paramedian incision should be made, the peritoneum opened and the abdominal cavity entered. An abdomen filled with blood is usually encountered first. The blood-filled cavity should be emptied by suction<sup>35</sup> and an immediate search for

bleeding points begun. Griswold and Ortners<sup>57</sup> and others have advocated re-infusion of this blood, even in the presence of fecal or biliary contamination. Some<sup>73</sup> have warned of the danger of reactions following re-infusion. We believe that autotransfusion should be used only when other blood or plasma is not available. Systematic exploration should be carried out according to a set routine. Bleeding points are usually found in the root of the mesentery, the omentum or in the solid viscera, such as the liver, pancreas or spleen. The exploration of the wound should be performed according to the entrance and exit of the bullet and the site of trauma. Perforations of the bowel should be ignored until profusely bleeding points have been located and hemorrhage controlled. Massive hemorrhage from large vessels may be controlled by digital pressure until the blood is removed by suction, the bleeding point visualized and a clamp applied. Bleeding from the spleen usually requires extirpation of the organ.<sup>23,24,43,58,134</sup> Perforations of the pancreas may be controlled by insertion of mattress sutures over a plug of macerated skeletal muscle or by packing. Wounds of the liver are best treated without surgical interference, unless there is profuse bleeding; in this event the wounds should be treated in a similar manner as the pancreatic wounds already described.<sup>25</sup> Hemorrhage from mesenteric vessels should be controlled by transfixion ligatures. However, it must be remembered that ligation of the large vessels may embarrass the circulation and cause an ischemia with possible resulting gangrene of portions of the bowel. Therefore, when hemorrhage has been controlled, before closing the abdomen, a careful search should be made of the entire contents to make certain that the blood supply is adequate; if inadequate, proper resections should be made.<sup>79,116,128</sup> After hemorrhage has been controlled, the site of perforation must be identified and sutured.

If no bleeding points are found shortly after the abdomen is opened, systematic



exploration of the colon should be done because of the large number of virulent organisms found in this structure and the danger of overlooking a colonic injury. Exploration should be started in the middle of the transverse colon, extending toward the right to the hepatic flexure down to the cecum, then returned to the starting point in the transverse colon, following the distal colon down to the rectum, examining each part for perforation and hemorrhage in the root of the mesentery. Following this, exploration should begin at the ligament of Treitz and follow the small bowel down to the ileocecal valve.<sup>84</sup> When exploration is begun in the middle of the ileum and extended in either direction, the Babcock marker may prevent the infliction of additional trauma to the gut from searching the same place several times.

Small solitary perforations of the bowel are usually closed without difficulty by a single purse-string suture,<sup>56</sup> reinforced with interrupted sutures of No. 50 cotton. When there are multiple perforations in close proximity, suture will produce stricture of the bowel; in this instance resection of the segment with end-to-end anastomosis would probably be the procedure of choice.<sup>109,130</sup> Lacerations of the bowel in the longitudinal manner should be closed transversely.<sup>128</sup> Large perforations of the bowel should be closed by a Connell suture with "ooo," 20 day, chromic catgut on an atraumatic needle, followed by interrupted Lambert sutures of No. 50 cotton. Small perforations of the colon may be closed in a similar manner.<sup>129</sup> Extensive injuries to the colon, however, should be treated by exteriorization, the Mikulicz type of procedure being the one of choice.<sup>56</sup> Resection or anastomosis of the large bowel in the presence of fecal contamination, shock or potential peritonitis should not be attempted.

The stomach and duodenum should be explored and perforations of the anterior surface repaired. Also, the posterior surface of the stomach should be explored by

opening the lesser sac through the gastrocolic omentum.<sup>15</sup> The posterior surface of the duodenum may be best explored by making an incision lateral to the outer border of the duodenum and retracting the duodenum medially to expose the retroperitoneal surface. The pancreas may be explored by opening the lesser sac. The posterior surface of the cecum is reached by opening the retroperitoneal space through a longitudinal incision in the peritoneum along the lateral border of the ascending colon and turning the cecum medially.<sup>124</sup> Perforations of the posterior surface of the cecum may be sutured in the usual manner. The retroperitoneal space should be drained by a stab wound in the flank with insertion of a rubber dam drain into the retroperitoneal space and closure of the peritoneum tightly from within.<sup>116</sup> Ice-pick and small shotgun wounds (bird-shot) usually need not be sutured as the serosa closes spontaneously without leakage.<sup>59</sup> If resection of the gut is necessary and the patient is in profound shock, the injured section should be exteriorized and a double barrel enterostomy or colostomy performed. Reconstruction of the fecal stream can be completed at a later date.

Bladder injuries are best handled as follows: If perforation is present it should be closed from the inside of the bladder and a catheter left in place as a suprapubic drain. All bladder wounds should have a suprapubic cystotomy.<sup>106</sup> Where there is danger of extravasation of the urine, a rubber dam drain should be placed in the suprapubic space of Retzius.

Although the local implantation of sulfonamides within the peritoneal cavity has been recommended by many<sup>47,67,75,80</sup> and it is probable that the sulfonamides are efficacious in controlling invasive infections such as peritonitis, however, we believe the systemic administration of the drug is preferable. The local implantation causes excessive exudation and undoubtedly interferes with wound healing. The peritoneum is closed with interrupted quilting cotton sutures.<sup>22,55,138</sup> A drain

should be placed down to the peritoneum<sup>126</sup> and the wound closed in layers in a similar manner.<sup>121</sup> Through-and-through sutures of stainless steel or silver wire may be used where rapid closure is indicated.<sup>16,46,68,98,100,105</sup> Additional sulfanilamide may be placed in the abdominal wound, although the present trend is away from local implantation.<sup>78,88,95</sup>

*Postoperative Care.* The usual postoperative orders for adults following exploratory laparotomy are as follows: (1) Morphine, gr.  $\frac{1}{4}$ , every four hours, times six, provided respirations are 14 or above. This dosage provides adequate sedation and increases the tonicity of the gut, thereby helping to prevent ileus.<sup>87</sup> (2) Wangenstein suction should be started,<sup>130</sup> using either the Levine tube or the Miller-Abbott tube to decompress the stomach and prevent accumulation of intestinal and gastric secretion.<sup>14,93</sup> The patient may be allowed to have small sips of water from time to time, thereby adding to his comfort and improving oral hygiene. (3) The application of a heat tent to the abdomen causes peripheral dilatation with a reciprocal constriction of the splanchnic area, as shown by Mueller,<sup>81</sup> and aids in the prevention of the pouring of excessive secretions into the gut. (4) The patient should be placed in the Trendelenburg position until he awakes from the anesthetic and then kept in Fowler's position. The Trendelenburg position aids in preventing cerebral anemia and shock, and allows secretions from the mouth and throat to drain out of the mouth instead of being aspirated into the trachea. Fowler's position tends to cause localization of peritonitis in the cul-de-sac, facilitating later drainage if necessary.<sup>72</sup> (5) The position of the patient should be changed every hour and deep breathing and coughing encouraged. This prevents pulmonary stasis, and the accumulation of bronchial secretions which forestalls atelectasis and pneumonia.<sup>104</sup> (6) The twenty-four hour urine output should be at least 1,500 cc. with a specific gravity of

1.015 or less. To maintain this level, 3,000 cc. of intravenous fluids daily (1,000 cc. of 5 per cent glucose in physiologic saline solution and 2,000 cc. of 5 per cent glucose in distilled water) are required. Coller and others have recently warned against the over administration of salt solution.<sup>27,77</sup> The kidneys tend to conserve chlorides in hypochloremia by a reduction in the excretion of salt<sup>13,42,45,97,132,133</sup> and the over-administration of saline may result in chloride intoxication.<sup>27</sup> (7) Blood should be administered according to the hematocrit, red blood count and hemoglobin readings. A few small transfusions are also indicated in combatting toxemia and infection. (8) Plasma should be administered when necessary as indicated by plasma protein determinations. Evidence of a toxic destruction of protein in postoperative patients has been noted by investigators and amino acids administered intravenously will aid in maintaining a positive nitrogen balance in patients unable to take food by mouth.<sup>2,28,34,63,111,125</sup> (9) Sodium sulfadiazine should be administered in doses of 6 Gm. every twenty-four hours intravenously, i.e., 2 Gm. three times in twenty-four hours. The sulfadiazine blood levels should be followed closely, the optimum level being 8 to 10 mg. per cent. Urinalyses should be done daily for the presence of red blood cells and sulfadiazine crystals in the urine. (10) Vitamins should be administered in the following doses: Vitamin C, 300 mg. per day; vitamin B<sub>1</sub>, 60 mg. per day; niacin, 150 mg. per day. Vitamin C is important in wound healing because it influences the deposition of collagen in wounds.<sup>50</sup> Vitamin B<sub>1</sub> increases the tone of the gut, thereby helping to prevent ileus. Nicotinic acid is the anti-pellagra vitamin. (11) The patient should be catheterized every eight to ten hours, if he is unable to void.<sup>86</sup> If repeated catheterization is necessary, an indwelling catheter should be inserted. (12) Oxygen should be given by B.L.B. mask or catheter to prevent anoxemia. High concentrations of

oxygen will also prevent ileus by aiding in the absorption of nitrogen from the gastrointestinal tract.<sup>21</sup>

The use of the Wangenstein suction apparatus should be continued until there is no ileus and active peristalsis can be heard by the stethoscope. If the patient is hungry, passing gas by rectum and a positive pyloric balance<sup>14</sup> is present, the suction may then be safely discontinued.

Surgical liquids consisting of fat-free broth and tea without cream or sugar may be started as soon as the suction has been discontinued. The diet should be gradually increased until the patient is receiving a regular tray. When the peritonitis and ileus have subsided, the nasal oxygen should be discontinued. The rubber dam drain placed to the peritoneum in the abdominal incision should be loosened, usually on the fourth day, and gradually withdrawn, but the removal of the drain should be dependent on the amount of drainage and inflammation present. Sulfadiazine as a rule is continued for about ten days, or until the patient's temperature has been normal for two days and all signs of peritonitis have vanished. The drug should be administered by mouth as soon as the Wangenstein suction has been discontinued and ileus has completely subsided. The dosage should be 1 Gm. every four hours, day and night, given in conjunction with equal amounts of sodium bicarbonate. However, as stated before, the dosage of the sulfonamides should be in amounts adequate to bring the blood level to between 8 and 10 mg. per cent.

*Postoperative Complications.* The postoperative complications considered here consist of one or more of the following: Postoperative atelectasis, thrombophlebitis or phlebothrombosis, localized intra-abdominal infection or abscesses.<sup>55</sup>

*Postoperative atelectasis* usually occurs in the first twenty-four hours following operation and is manifested by a chill, fast pulse, and a rapid rise in temperature to between 103°F. and 105°F. The patient shows signs of dyspnea and apprehension

and may or may not complain of pain on the affected side of the chest. Examination reveals absence of breath sounds and dullness over the affected lobe with a shifting of the heart and mediastinum toward the affected side. The treatment consists in removing the obstruction to the bronchus, which is usually a plug of inspired mucus or aspirated vomitus. The patient should be turned on the unaffected side and made to take deep breaths and cough violently. This will usually result in the expectoration of a thick plug of mucus, followed by prompt subsidence of symptoms. If this measure fails, a catheter connected to a motor suction apparatus can be introduced through the nose into the trachea; by a combination of tracheal irritation and aspiration, the obstruction can be removed. If these two simple measures are ineffective, the patient must be bronchoscoped and the bronchial tree aspirated under direct vision. In the seriously ill this should be done at the patient's bedside. Recurrence of atelectasis must be prevented by changing the position of the patient often and encouraging deep breathing and coughing at least once each hour.

Much has been written recently concerning *thrombophlebitis* and *phlebothrombosis*, especially in regard to the prevention of postoperative pulmonary embolism associated with these conditions.<sup>3</sup> Ochsner and DeBakey have written extensively describing the difference between the two conditions and the method of treatment in each.<sup>29,89,91</sup>

In *thrombophlebitis* the clot results from an inflammatory reaction in the vein and is firmly attached to the vein wall. Embolism does not occur unless a loosely attached red or coagulation thrombus forms proximal to the fixed white thrombus. On the other hand, in *phlebothrombosis* the intravenous clot is the red or coagulation variety unassociated with inflammation of the vein wall. Here, the clot is loosely attached to the vein and may be easily detached with resultant development of an embolus.<sup>91</sup>

Clinically, thrombophlebitis presents the picture of chills, fever, tenderness over the involved vein with increased local heat and marked edema of the extremity. In the patient with phlebothrombosis, however, the signs and symptoms are minimal. The patient usually has a pulse rate out of proportion to the temperature and the condition is frequently accompanied by a sense of impending disaster. Chills, fever and edema are usually absent. There may be tenderness over the deep veins of the calf or foot. Dorsiflexion of the foot usually causes pain in the calf (Homans' sign).<sup>66</sup> Unless the patient has been watched carefully, the first indication of phlebothrombosis is often a fatal, or nearly fatal, pulmonary embolism. When phlebothrombosis is suspected, the diagnosis can be confirmed by phlebography.<sup>30,40,117,131</sup> Briefly, the technic consists of injection of 20 cc. of 35 per cent diodrast into the dorsal vein of the foot or ankle and exposure of a roentgenologic plate. In this way, the veins may be visualized and any defect in filling denotes the presence of intravascular clotting.

Prophylaxis is, of course, of primary importance. Any condition which provokes venous stasis should be avoided. Post-operatively, the patient should be encouraged to move his legs frequently, take deep forceful breaths and change his position in bed at regular intervals. Tight abdominal dressings should not be used and abdominal distention should be controlled as much as possible. In older patients the legs should be wrapped in elastic bandages from the toe to the groin, to promote venous return and prevent stasis in the lower extremities. The legs should be examined daily for evidence of tenderness or edema.

Once intravascular clotting has occurred, the type must be determined and proper therapy instituted. If a diagnosis of thrombophlebitis is made, we have found that the condition responds rapidly to daily lumbar sympathetic blocks;<sup>29,89</sup> external heat in the form of a heat tent with

elevation and support of the edematous extremity by elastic bandages<sup>91</sup> are also of value. Pulmonary embolism ordinarily does not occur in these patients, as the clot is fixed to the vein wall by the inflammatory process. Allen,<sup>3</sup> Fine<sup>39,40</sup> and others have advocated routine ligation of the femoral veins for thrombophlebitis. We, however, have not found this procedure necessary and have prevented the formation of stasis clots proximal to the fixed clots by active motion, relief of arteriospasm by lumbar sympathetic blocks and the application of heat and elastic bandages. Ligation of the femoral vein in thrombophlebitis has been reserved for those occasional patients in whom the process progresses to suppuration or pyophlebitis. When this occurs, ligation of the femoral vein is done in order to prevent the dissemination of liquefied infected thrombi into the blood stream.

In phlebothrombosis, however, one is dealing with a different and deadly mechanism. The clot is not fixed and there is grave danger of pulmonary embolism. As soon as the condition has been proved by phlebography,<sup>30,39</sup> the femoral vein should be ligated immediately. Approach to the femoral vein is best accomplished through a longitudinal incision in the groin. The saphenous vein should be identified and retracted and the femoral vein exposed above the profunda. Temporary ligatures should be provided by traction with small rubber catheters encircling the vein. The femoral vein should be opened and a No. 16 rubber catheter or an angulated glass drinking tube introduced into the external iliac. Aspiration of the vein by suction should be done to remove any clot proximal to the proposed point of ligation.<sup>3</sup> The common femoral vein should then be doubly ligated with No. 20 crochet cotton and the wound closed. Oddly enough, edema of the extremity following this procedure rarely occurs,<sup>3</sup> but when it does it is easily controlled by an occasional lumbar sympathetic block.

The most common site for localization of peritonitis following intra-abdominal injury is the cul-de-sac, especially if the

for evidence of tenderness over the right twelfth rib. If a subdiaphragmatic infection is present, fluoroscopy will reveal elevation

### ABDOMINAL INJURIES

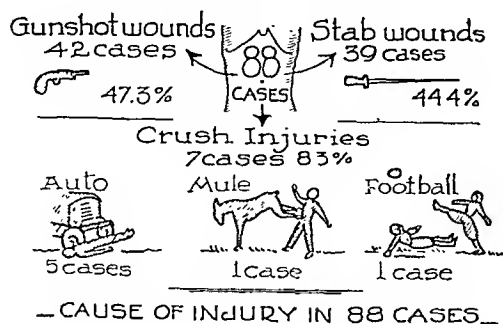


FIG. 1. Drawing illustrating the cause of injury in authors' eighty-eight cases of abdominal injury.

patient has been kept in Fowler's position. The diagnosis is usually obvious if this possibility has been kept in mind. The patient begins to run a low spiking fever in the second postoperative week which gradually increases to  $102^{\circ}$  or  $103^{\circ}\text{F}$ . Diarrhea and tenesmus are frequent complaints. On rectal examination, the sphincter is found to be relaxed and a firm mass is found in the cul-de-sac bulging into the rectum.<sup>85</sup> If fluctuation is present, an area of softening may be felt, which has been aptly described as "the rotten spot in an apple." The treatment, of course, consists in incision and drainage through the anterior rectal wall and the insertion of a soft rubber tube into the abscess. The prompt subsidence of symptoms will be most gratifying.

Another complication of peritonitis to be discussed here is *subdiaphragmatic abscess*.<sup>90,115</sup> The most common site of localization beneath the diaphragm is the posterior superior space, which is a small triangular area located above the liver between its posterior surface and the diaphragm at the level of the right twelfth rib.

The patient manifesting systemic evidence of persistent infection following peritonitis should be examined frequently

### Race and Sex Incidence

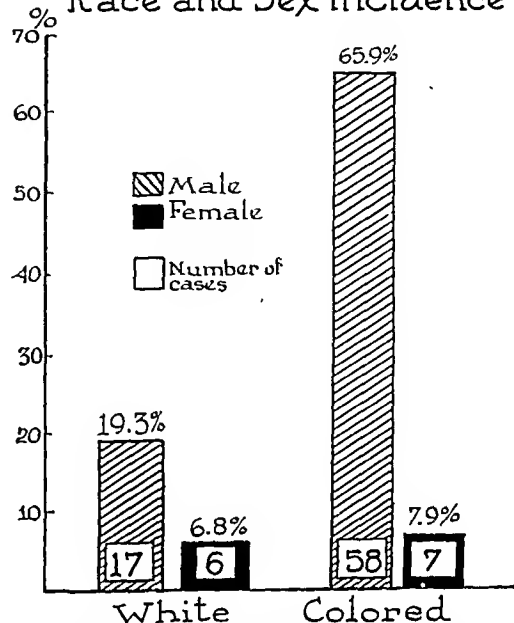


FIG. 2. Graphic representation of race and sex incidence in authors' eighty-eight cases.

and immobilization of the right diaphragm. Roentgenograms will show, in the lateral view, an elevation of the posterior portion of the diaphragm with obliteration of the posterior costophrenic angle; in the antero-posterior view an obliteration of the costophrenic angle and elevation of the lateral portion of the diaphragm<sup>83</sup> will be seen. Most of these infections subside with conservative therapy. If, however, an abscess forms it should be drained according to the extraperitoneal approach.<sup>26,90,92</sup> In brief, the technic consists in making an incision over the right twelfth rib, which is resected subperiosteally. A transverse incision should then be made opposite the first lumbar spine through the rib bed down to the peritoneum. The peritoneum should then be peeled from the undersurface of the liver until the abscess is reached and the finger plunged into the cavity. Drains should be inserted and the wound left open. This procedure has the distinct

advantage of not traversing the uninvolved peritoneal or pleural cavity.

#### CASE REPORTS

A brief analysis of eighty-eight cases of abdominal injuries is presented in graphic

mortality of 13.6 per cent. Of the ten patients on whom no operation was performed, four died, or a mortality of 4.5 per cent, when one considers the total 88 cases. These four patients were practically moribund at the time of admission to the hospital and surgery in any

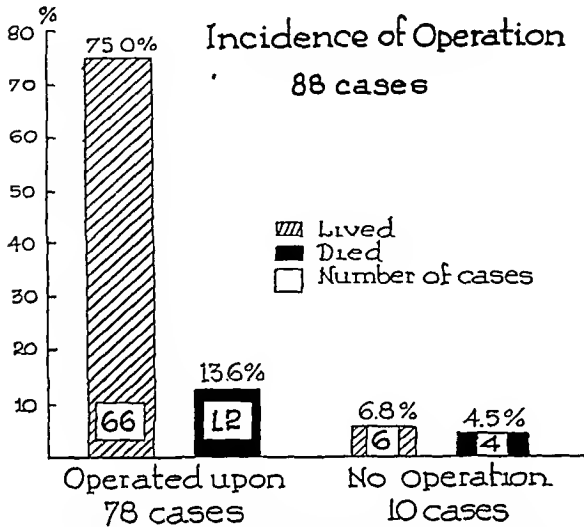


FIG. 3. Graphic representation of incidence of laparotomy and mortality in authors' cases.

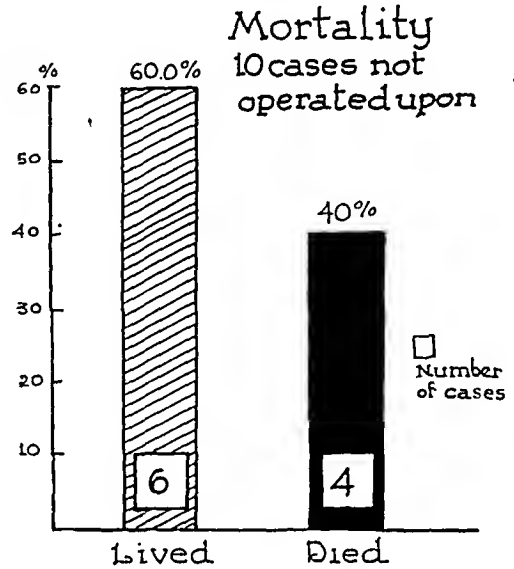


FIG. 4. Graph showing the mortality in patients not operated upon.

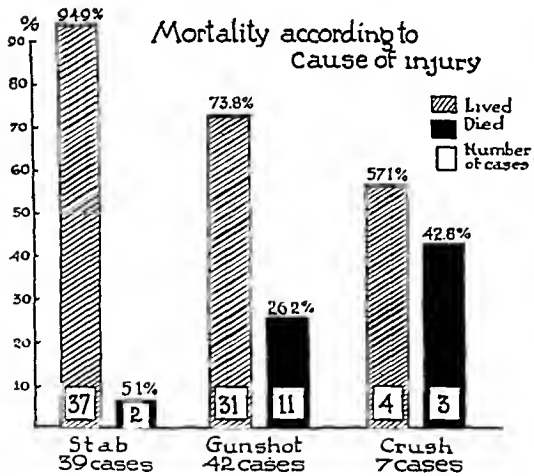


FIG. 5. Graph showing the mortality according to the cause of injury.

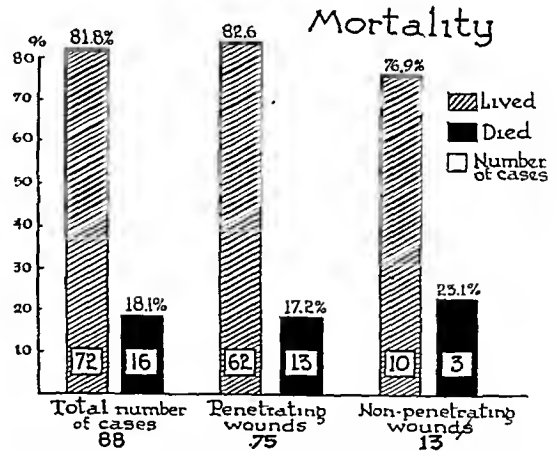


FIG. 6. Graphic representation of mortality according to type of wound.

detail. In Figure 1 is illustrated the cause of injury; the crush injuries being divided into three specific types. Incidence of race and sex is shown in Figure 2 and it should be noted that there is a preponderance of injuries to negro men. Of the eighty-eight patients, seventy-eight were operated upon, with a

form would have hastened the lethal exitus. These results are shown in Figure 3. The ten non-operative cases when considered separately show a mortality of 40 per cent as shown in Figure 4.

The mortality according to the cause of injury is further elaborated upon in Figure 5,

the mortality rate being highest in the crush injuries (42.8 per cent) and lowest in the stab injuries (5.1 per cent). This is undoubtedly due

thirteen patients died, giving the highest mortality rate of 23.1 per cent. This may be explained by the fact that these three patients suffered severe crush injuries.

Analysis according to the site of injury, as shown in Figure 7, is self-explanatory. It is realized that the number of cases is too small to be of great statistical value, but a detailed account of the injuries is shown. Table 1 is an analysis of the sixteen deaths in the series. A predominance of pistol shot wounds was found. In this group of patients either a hollow viscus was penetrated or the liver severely damaged; in some patients both types of injury were present. In the series, there were two stab wounds. In one patient the duration of time after injury and before operation was eight hours and forty minutes. Postoperatively he developed a severe transfusion reaction, followed by anuria with uremia, and death ensued on the fifth postoperative day. The three patients with crush injuries, shown in Table 1, have already been discussed.

Table II shows the effect of the time interval before operation on the mortality in the seventy-eight patients operated upon. It should be noted that there is an increase in the mortality percentage as the time interval before operation increased. Those patients who were operated upon within two hours from the time of injury had no mortality. The shortest time interval was thirty minutes and the longest interval twenty-five hours and ten minutes, or an average time of seventy minutes from the time of injury until operation was performed.

Table III is illustrative of the effect of the duration of operation on the mortality in seventy-eight patients. When the operating time was less than one hour there was a mortality rate of 10 per cent. The shortest time for operation was fifteen minutes, the longest 265 minutes and the average time per operation was 100 minutes. It should be noted that the mortality percentages increased as the time interval increased up to two and one-half hours. It is interesting to note that in the seven patients in whom the duration of the operation was two and one-half hours or longer, the rate was only 14.3 per cent, as compared to those in whom the duration was for a shorter period of time. Whereas speed, up to the maximum point of efficiency, is essential to save these patients, it must be remembered that the increase in the time of

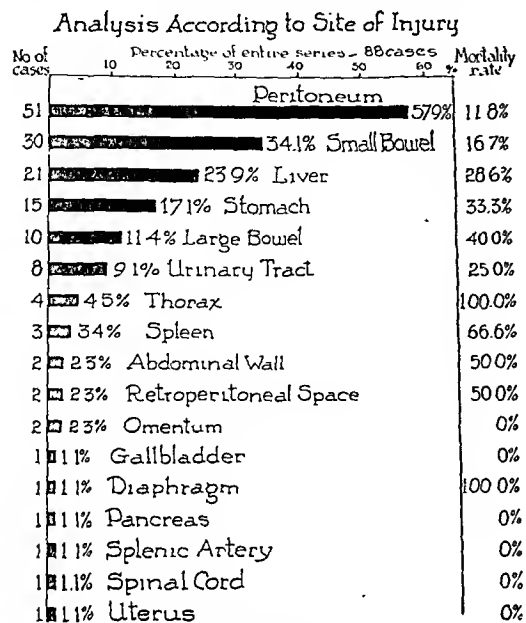


FIG. 7. Graphic representation of analysis of cases according to the site of injury.

to the fact that many of the stab injuries were non-penetrating. There were seven crush injuries, as shown in Figure 1, and of these, five were due to automobile accidents, one was due to a kick by a mule and one to traumatic injury while playing football. Two of the patients receiving crush injuries suffered multiple intra-abdominal injuries; one patient had a ruptured liver and fractured rib and the other had a ruptured spleen, fractured rib, fractured pelvis and lacerated urethra accompanied by hemothorax. Both of these patients died of shock and hemorrhage within two hours after admission. The third patient had a ruptured liver, but was not seen until nine hours after injury. This patient was operated upon and died on the tenth postoperative day from pulmonary hemorrhage. Necropsy was not permitted. The mortality rate, classified according to penetrating and non-penetrating injuries, is shown in Figure 6. Of the total number of eighty-eight patients, sixteen died, or a mortality rate of 18.1 per cent. Seventy-five of the injuries were of the penetrating type, i.e., with laceration of the peritoneum, and thirteen of these patients died, making a mortality rate in this group of 17.2 per cent. Of the non-penetrating injuries, three of the

operation is due to the greater amount of damage to the tissues. Also, as emphasized by Rippy<sup>107,108</sup> there is an increased incidence of missed visceral perforations in operations performed too hastily.

one-half days. The longest hospital stay (seventy-three days) was necessary for a patient with a crush injury and the shortest (one day) for a patient with a stab wound.

The types of anesthetic used are shown in

### ANALYSIS OF DEATHS—SIXTEEN CASES

No.	Type of Injury	Age	Site of Injury	Duration before Operation	Duration of Operation	Postoperative Sulfonamides	Resection	Cause of Death
1	Pistol	39	Liver, thorax	9 hrs.	105 min.	Yes	No	Shock and hemorrhage (24 hrs. p.o.)
2	Pistol	46	Large bowel	330 min.	165 min.	Yes	No	Pneumonia and peritonitis, hematuria (4th. p.o. day)
3	Pistol	21	Stomach, Large bowel	Unknown	135 min.	Yes	No	Shock and hemorrhage (24 hrs. p.o.)
4	Pistol	16	Small bowel	270 min.	75 min.	Yes	No	Shock and hemorrhage (24 hrs. p.o.)
5	Pistol	27	Stomach, Large and Small bowel	9 hrs.	75 min.	Yes	No	Shock and hemorrhage (24 hrs. p.o.)
6	Pistol	35	Peritoneum	9 hrs.	75 min.	Yes	No	Pneumonia (8th. p.o. day)
7	Pistol	35	Large and small bowel, retroperitoneal space	150 min.	135 min.	Yes	No	Peritonitis and toxemia (3rd p.o. day)
8	Pistol	15	Multiple shot in abdomen	No Operation		No	No	Shock and hemorrhage (1 hour)
9	Pistol	18	Stomach, small bowel, thorax	450 min.	135 min.	Yes	No	Shock and hemorrhage (12 hrs. p.o.)
10	Pistol	20	Small bowel, spleen, stomach, mesentery, liver	645 min.	93 min.	Yes	Splenectomy	Shock and hemorrhage (7 hrs. and 45 min. p.o.)
11	Pistol	19	Liver, diaphragm	490 min.	120 min.	Yes	No	Shock, hemorrhage, liver damage (13 hrs. p.o.)
12	Stab	31	Stomach	520 min.	80 min.	Yes	No	Transfusion reaction, anuria, uremia. (Death on 5th p.o. day)
13	Stab	20	Multiple stab wounds in abdomen	No Operation		No	No	Shock and hemorrhage (10 min. after admission)
14	Crush	51	Ruptured liver, fractured ribs	No Operation		No	No	Shock and hemorrhage (2 hrs. after admission)
15	Crush	33	Ruptured spleen, fractured ribs, pelvis and urethra, hemothorax	No Operation		No	No	Shock and hemorrhage (2 hrs. after admission)
16	Crush	58	Ruptured liver	450 min.	52 min.	No	No	Pulmonary hemorrhage (10th p.o. day)

TABLE 1. Table showing an analysis of sixteen deaths.

The average duration of time before admission after injury was seventy-eight minutes, the shortest interval being fifteen minutes and the longest 762 minutes, or twelve hours and forty-two minutes. The average hospital stay for the patients who survived was fifteen and

Figure 8. It should be noted that ethylene and ether were used in twenty-six patients and cyclopropane in twenty-four patients. A few of the patients in the ethylene and ether group were started on cyclopropane and later switched to ether because of increased pulse



rate and blood pressure; also, extrasystoles were noted in a few instances. Cyclopropane was used in twenty-four patients, and it is our

exhibited. In six patients the spinal anesthetic had to be supplemented by cyclopropane because of the length of time necessary for

### Effect of Time Interval Before Operation on Mortality 78 cases

	Cases	Percentage of Total	Number of cases died	Mortality Percentage
Less than 2 hours	17	21.8%	0	0%
2 to 4 hours	23	29.2%	1	4.3%
More than 4 hours	34	42.3%	10	29.4%
Unknown	4	5.1%	1	25.0%

Total 78

Shortest time—30 minutes

Longest time—25 hours, 10 minutes

Average time—70 minutes

TABLE II. Table showing the effect of time interval before operation on the mortality in seventy-eight cases.

belief that it is an excellent anesthetic as long as no cardiac arrhythmia or rise in blood pressure appears. A spinal anesthetic was used in nine patients in whom no shock was evident at the time of admission, or, if present, responded to therapy, remaining stable for a period of one and one-half to two hours. A

operation. In three patients a local anesthetic was used, but we believe that it should seldom, if ever, be used when exploration is necessary. However, in these three patients the wounds were superficial and infiltration was made about  $1\frac{1}{2}$  cm. away from the wound edge. In one patient ether by the open drop method

### Effect of Duration of Operation on Mortality 78 cases

	Cases	Percentage of Total	No of cases Died	Mortality Percentage
Less than 1 hour	10	12.8%	1	10.0%
1 to $1\frac{1}{2}$ hours	27	34.6%	4	14.8%
$1\frac{1}{2}$ to 2 hours	19	24.3%	3	15.3%
2 to $2\frac{1}{2}$ hours	13	16.6%	3	23.1%
$2\frac{1}{2}$ hrs or over	7	8.9%	1	14.3%
Unknown	2	2.6%	0	0.0%

Shortest operation—15 min.

Longest operation—265 min

Average duration of operation—100 min

TABLE III. Table showing the effect of duration of operation on mortality in seventy-eight cases.

spinal anesthetic is the anesthetic of choice in so far as relaxation is concerned. However, it is definitely contraindicated when shock, impending shock, or low blood pressure are

was used, the reason for this being that Charity Hospital at New Orleans is a teaching institution and the Department of Anesthesia requested that the anesthetist be given a

chance to administer ether by the open drop method. Divinyl ether (Vinethene) was used as the induction agent in the latter case. The

with lower bowel contents, should be drained through a stab wound in the flank. A drain should also be placed if there has been injury

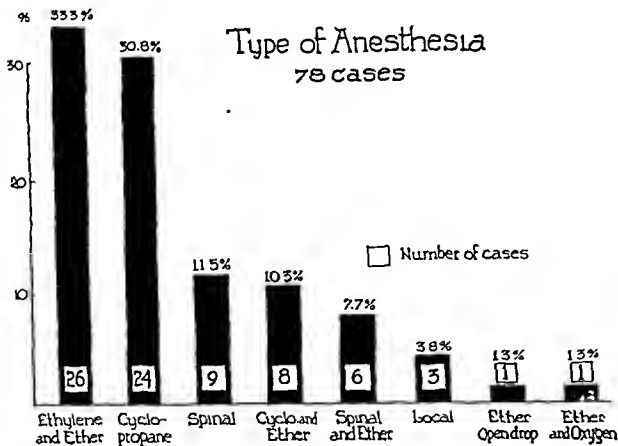


FIG. 8. Graph showing the type of anesthetic used.

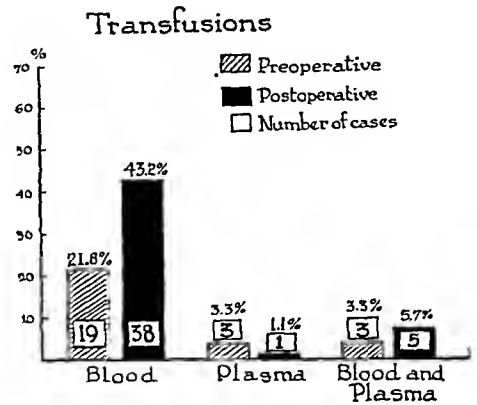


FIG. 9. Graph illustrating the number and type of transfusions used.

choice of anesthetic agents has been discussed previously.

Transfusions are graphically shown in Figure 9. Their value in abdominal injuries needs no further emphasis. The seriously wounded received whole blood, plasma or blood and plasma preoperatively, during the operation and postoperatively as their condition demanded.

There has been considerable controversy over the local implantation of sulfonamides. Hawking<sup>62a</sup> has determined in the experimental animal the local concentration and rate of absorption after local implantation. This method of administration gives high immediate concentration because of the rapid rate of absorption. However, after twenty-four hours the residual local concentration is slight. The disadvantages of local implantation lead us to believe that systemic administration is preferable. Figure 10 shows results obtained with and without chemotherapy.

In thirty of the seventy-eight patients upon whom operation was performed, complete closure of the abdominal wound was accomplished; in forty-eight patients drainage was established, as is graphically shown in Figure 11. Figure 12 depicts the method of drainage used in these forty-eight patients; in forty-three (88.7 per cent) a Penrose drain was placed down to the peritoneum in the wound after the peritoneum had been closed. We believe, as most authors do, that it is impossible to drain the peritoneal cavity; however, the kidney fossa and retroperitoneal spaces, if contaminated

to the pancreas or biliary tract in order to provide escape for leakage of pancreatic juice or bile. In four patients such drainage was necessary. In one patient who had received a stab wound of the liver, there was considerable hemorrhage which was controlled by a gauze pack placed in the peritoneal cavity.

In seventy-eight patients healing of the wounds is illustrated by Figure 13. Sixty-two healed by primary intention, eleven had a serious infection and five a trivial infection. Trivial infection, as defined by us, is "a superficial infection which did not prolong the patient's stay in the hospital," whereas a serious infection is defined as "one that did prolong the patient's stay in the hospital." The type of suture material used is an extremely important factor in wound healing. We prefer cotton. One of us (A.O.) has often made the statement that if cotton could be used in only one type of case, his preference would be to limit its use to the closure of a grossly contaminated wound. It has been emphasized previously that the one contra-indication to the use of non-absorbable suture material is contamination or infection. Our reasons for selecting cotton for closure of grossly contaminated wounds are based on observations made on wound healing in the Department of Surgery at the School of Medicine, Tulane University, and by experimental work carried out at Charity Hospital, in which three kinds of suture material were used:

catgut, silk and cotton. We have found that all catgut-closed wounds became infected, that 70 per cent of similarly grossly contaminated

sutures are used. Fibroplasia is not complete until the infection has subsided, but during this time the cotton sutures remain and hold

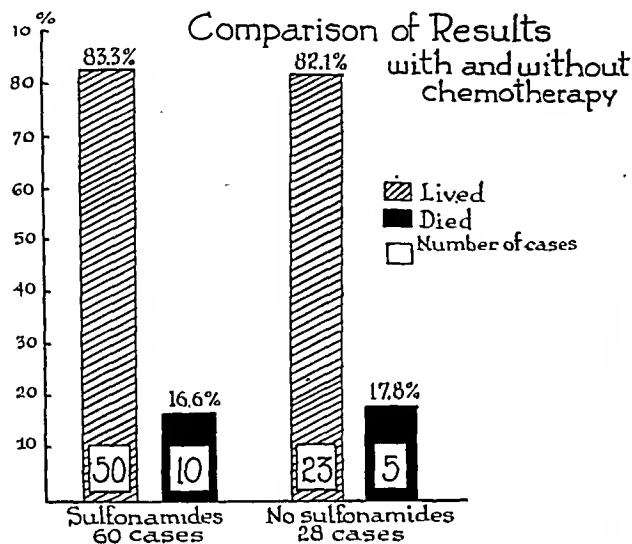


FIG. 10. Graph showing a comparison of the results obtained with and without chemotherapy.

wounds closed with silk became infected and that only 52 per cent of similarly contaminated wounds closed with cotton became infected. These studies have demonstrated that cotton-closed wounds are less likely to become infected than wounds closed with catgut or silk.

In the presence of infection, wound healing is retarded and fibroplasia, instead of being complete in eight to fourteen days, is delayed until the infection has subsided for from two to four weeks. In the wounds closed with catgut, there is a definite period of time when the wound edges are held by nothing except wound exudate because catgut sutures, instead of remaining intact for the customary length of time (fourteen to twenty-one days), are digested with abnormal rapidity, due to the large amount of proteolytic enzyme (leucoprotease) derived from the exudate in the wounds. The high incidence of wound disruption and postoperative hernia in infected abdominal wounds which have been closed with catgut is thus accounted for. In 48 per cent of contaminated wounds closed with cotton, healing by primary intention occurs without infection. In 52 per cent with infection there is the same degree of retardation of wound healing as is present when catgut

## Closure of Wounds

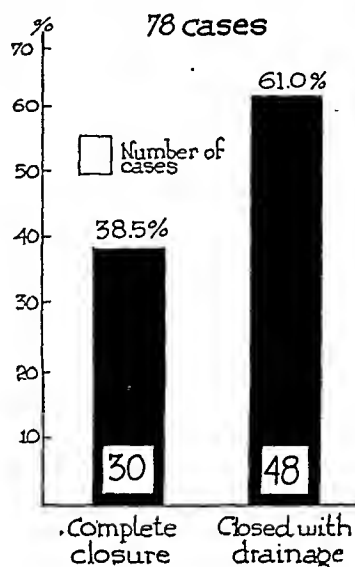


FIG. 11. Graph illustrating the number of operative wounds completely closed and those closed with drainage.

the wound edges together. We have thus practically eliminated wound disruption and postoperative hernia. The incidence of persistent sinuses in infected wounds closed with cotton is extremely rare, but the condition in wounds similarly closed with silk has been frequently found. In the occasional instance when a sinus does develop in the wound closed with cotton, it usually disappears early.

## CONCLUSIONS

We believe the following points are extremely important:

1. The classification and early treatment of patients in shock, in order that the time of exploration may be determined. The patients should be classified as those in shock or impending shock and those without shock. After treatment, they should be classified as those who respond to adequate shock therapy, becoming stabilized for a period of one to two hours; those who respond to therapy for a short period of time only, subsequently relapsing into

their original state; and, lastly, those who do not respond to adequate treatment of shock and continue in profound collapse.

tinued shock for one to one and one-half hours despite adequate measures to combat shock; (2) in the torn abdominal wall with

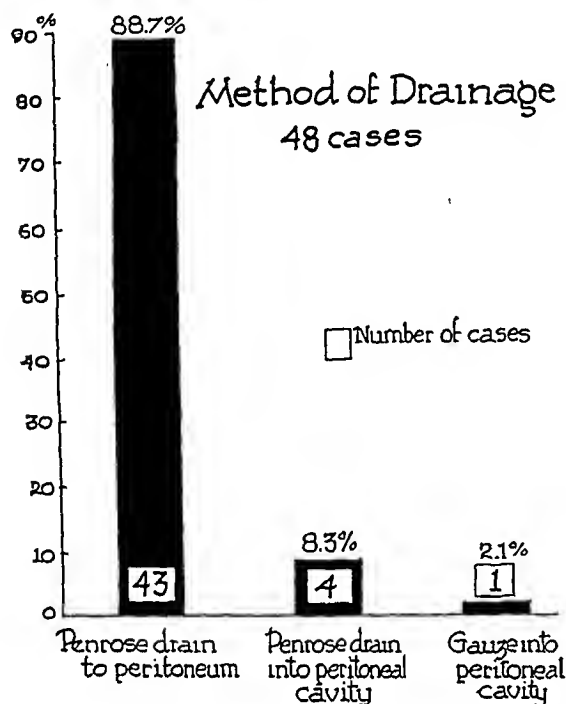


FIG. 12. Graph illustrating the types and methods of drainage used.

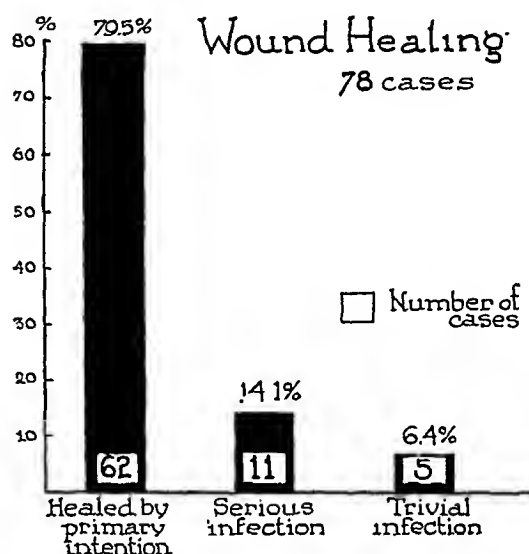


FIG. 13. Graph showing the number of patients who healed by primary intention and those developing infection.

2. The falling drop method for serum protein determination and repeated hematocrit readings are accurate aids in diagnosis and an excellent means of determining whether hemorrhage is progressing, decreasing or remaining static.

3. Roentgenologic studies are invaluable; however, negative findings do not always indicate a hollow viscus has not been perforated.

4. Exploratory laparotomy is usually not indicated in the following conditions: (1) In any injury until shock has been controlled; (2) in the non-penetrating wound in which trauma from a blunt instrument has played no rôle; (3) in wounds made with a sharp instrument, such as an ice-pick, or multiple bird-shot; (4) in hopeless cases in which the injuries are of long duration and anatomical or functional restitution is impossible.

5. In the following conditions exploratory laparotomies are indicated: (1) Con-

lacerated gut protruding; (3) when there is definite evidence of rupture of a hollow viscus; (4) in the presence of increasing abdominal pain and rigidity; (5) when air under the diaphragm is present; (6) in the presence of an increasing pulse rate with questionable evidence of intra-abdominal injury; (7) in injury to the kidney when there is evidence of excessive retroperitoneal hemorrhage; (8) in bladder injuries, as determined by hematuria, cystography and cystoscopy.

6. Gas (ethylene) followed by ether and oxygen is the anesthetic of choice because it allows a high oxygen concentration, requires a relatively short induction period and induces complete relaxation.

7. The choice of incision is determined by the site of the injury. In most cases, however, the paramedian incision is most adaptable and allows the best exposure.

8. The systemic administration of sulfonamides is preferable to local implantation.

9. Cotton suture material, as shown by our experimental studies, is preferred for closure of wounds.

10. The abdominal cavity cannot be drained; therefore, drainage down to the peritoneum is essential in contaminated wounds. This prevents rupture of an abdominal wall abscess into the peritoneal cavity.

11. The postoperative care is briefly outlined and the postoperative complications (atelectasis, thrombophlebitis, phlebotrombosis localized intra-abdominal infections and abscesses) should be constantly watched for and early treatment instituted.

12. A brief analysis of eighty-eight personal cases is presented.

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THE effects produced by *gunshot wounds* vary according to the velocity and size of the missile and the area wounded, from a simple drilling or perforating wound to extensive disorganization or explosive disruption of tissue.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).



# AIR EMBOLISM\*

## FATAL AIR EMBOLISM DUE TO POWDER INSUFFLATORS USED IN GYNECOLOGICAL TREATMENTS

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RECENTLY the author was called upon to investigate two deaths occurring in doctors' offices, after the vaginal insufflation of dry medicinal powders for the relief of pruritus vulvae.

Necropsies disclosed that these deaths were due to massive air embolism of the pulmonary variety. The right side of the heart in both cases was markedly distended with air, which blocked further entrance of venous blood, prevented proper ventricular contraction and caused sudden death. During the powder insufflation, air had, unwittingly, been blown into the uterine cavities.

Since insufflators are in daily use in office gynecological practice for the treatment of pruritus vulvae, trichomonas and monilia infections, et cetera, it becomes imperative to indicate the elements of danger in indiscriminate and improper use of these devices. Such catastrophies, however, must be rare.

*CASE 1. Sudden Death in Doctor's Office after Insufflation over External Genitals of Stovarsol Powder. Cribriiform Hymen.* A white woman, aged twenty-two, consulted a physician complaining of slight discharge and intense vulval itching. This patient had just completed a menstrual period and was bashful, highly nervous and crying. Examination revealed a well nourished patient, weighing 129 pounds. Systolic blood pressure was 128, diastolic 72; pulse 88 per minute.

The doctor advised her to return with her mother and he would examine her, but in order to give her temporary relief he would blow some powder over the external genitalia.

The physician then placed the patient on

his examining table and inserted the glass tip of an old type vaginal powder blower (Fig. 1) between the labia and squeezed the bulb about six times, insufflating stovarsol powder.\*

It was determined later that 6 compressions of the insufflator bulb used in this case would displace more than 300 cc. of water. (Fig. 2.)

The patient at the end of the last compression of the bulb, felt faint, became pulseless, breathed about twelve times and died on the examination table. All attempts at resuscitation failed including artificial respiration by a Police Rescue Squad using the prone-pressure method.

Necropsy was performed *fourteen hours* after death and showed no postmortem decomposition in any of the organs or tissues. There was marked lividity over the back of body fading on pressure and the lips and finger nails were cyanotic.

The hymen was intact and cribriform in type with three small openings, the largest being 8 mm. in diameter. There were no tears or lacerations around external genitalia and no hemorrhages around or in the hymen. Considerable powder was present over the external genitals.

Because of the possibility of air embolism, the sternum was partially removed without disarticulation at the sternoclavicular joints or cutting the cartilages of the first and second ribs.

On opening the pericardium the whole right side of the heart was ballooned out and tympanic on percussion. The inferior and superior vena cavae appeared distended with air bubbles and foamy blood.

On filling the chest cavity and pericardium with water and opening the right ventricle

\*Stovarsol is an arsenical preparation. Dermatitis and even deaths from arsenical poisoning have occurred after the use of this preparation.

\* From the Office of the Chief Medical Examiner of Essex County (Newark) N. J.; the Department of Pathology of the Newark City Hospital; and the Department of Forensic Medicine, New York University College of Medicine.

under water large bubbles of air escaped with a small amount of foamy blood. The endocardium and valves of the right side of the heart were normal and showed no evidence of hemolysis. The foramen ovale showed a small opening anteriorly but was physiologically closed. No apparent air was present in the left side of the heart or in the coronary arteries. The endocardium and valves of the left side of the heart were normal and likewise showed no evidence of hemolysis. The aorta, coronary arteries and myocardium were normal.

Both lungs were crepitant and showed only the slightest amount of terminal, frothy edema. No areas of acute interstitial emphysema were found. Occasional petechial hemorrhages were present on the visceral pleura and in the epicardium over the apex.

The inferior vena cava and veins of the broad ligaments contained numerous air bubbles and frothy blood. There was no air in the ovarian veins.

The uterus was normal in size, consistency and conformation. The cervix was small, virginal in appearance and showed a small amount of mucosal hemorrhage over the vaginal surface and in the cervical canal. The endometrium over the posterior wall of the uterine cavity, just above the cervix, showed areas of irregular mucosal hemorrhage. The uterine cavity was clean and showed no evidence of pregnancy.

Both tubes were normal and not distended. The right ovary contained a small hemorrhagic corpus luteum (corpus of menstruation.) The vagina contained considerable powder over its walls and in the fornices, but there was no powder in the cervical canal or in the uterine cavity.

The rest of the organs including the brain were normal and no other cause of death was encountered.

A complete toxicological examination showed no volatile or other poisons.

Immediately after the autopsy, a death certificate was issued giving the following cause of death:—"Sudden death in physician's office; air embolism following insufflation of powder into vagina for treatment of pruritus."

*Comment.* The intact, virginal, and cribriform hymen in this case played an important rôle in the causation of the air

embolism. The doctor, believing he was spraying powder over the external genitals, must have unknowingly held the glass tip



FIG. 1. Old type vaginal powder blower used in Case 1.

of the insufflator directly over the largest hole in the hymen and have blown powder and air into the vagina. The air entrapped in the vagina is forced into the uterine cavity since its escape below is obstructed by the intact hymen and the shape of the insufflator.

The mechanics of what took place in this case is illustrated diagrammatically in Figure 3.

The exact point of entry of air into the venous circulation in this case can not be actually demonstrated. There is no evidence to indicate that it entered the veins of the external genitals or vagina, since no hemorrhage or lacerations were found in these locations.

However, the recent hemorrhage in the cervical canal and lower uterine zone all point to this area as the portal of entry. Furthermore, the presence of air in veins of broad ligaments in their lower portions, and the absence of air in the ovarian veins, favors the lower uterine zone as the source of the embolism.

In air embolism the exact point of entrance is often not visible, and it is not necessary to see one large, open vein.

The fact that the patient had just passed a menstrual period also favors engorgement and distention of the uterine veins.

Some authorities have stated that vaginal insufflation should not be given around

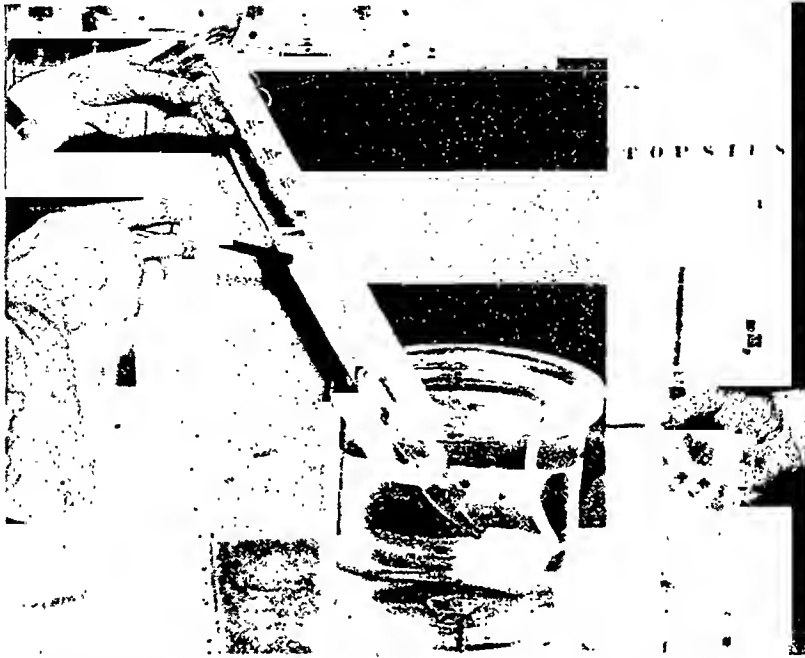


FIG. 2. Showing displacement of over 300 cc. of water by six compressions of the bulb.

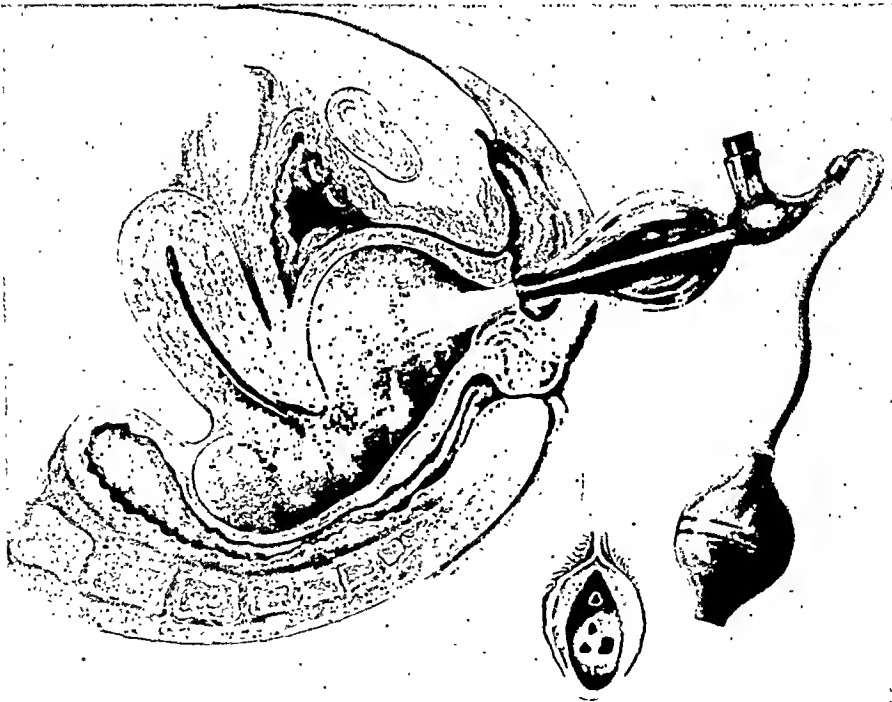


FIG. 3. Mechanism of fatal air embolism in Case 1. The cribriform, intact, hymen; vagina ballooned with air and coated with powder; and the hemorrhage in cervical canal and over posterior wall of uterine cavity may be noted.

the menstrual periods, but they often are, since trichomonas infections usually cause the worst pruritus after time.

on percussion. There were distinct linea nigra and increased pigmentation about the nipples and colostrum in the breasts. Lips and finger

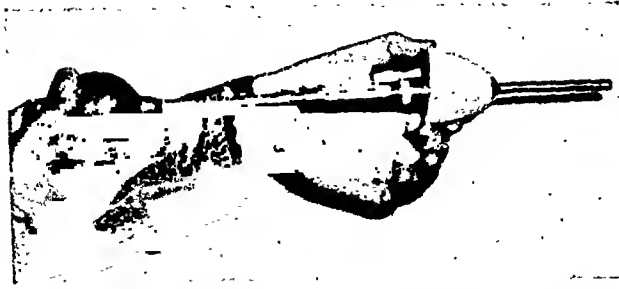


FIG. 4. Metal insufflator used in Case II. Note metal nozzle 3 inches long, and rubber dam to fit against external genitals. It was determined that six compressions of the bulb displaced 200 cc. and nine compressions 300 cc. of water.

**CASE II. Sudden Death in Physician's Office after Insufflation of Vioform Powder into Vagina. Six Months Pregnant.** A colored woman, age twenty-seven, a primipara, six months pregnant, was told that she could not have a baby on account of deformed pelvis. She consulted another physician to check this and to engage him for her confinement. She was complaining of intense itching about the genitals.

The doctor placed her on his x-ray table in order to take roentgenograms of her pelvis. Before doing this, he inserted the metal tip of a vaginal insufflator (Fig. 4) into the vagina and insufflated vioform powder\* to relieve her pruritus. He thinks he compressed the bulb seven or eight times holding the rubber shield of the insufflator tightly against the labia.

Towards the end of the insufflation, the patient suddenly sat up, complained of being dizzy and fell back pulseless, apparently dead.

Ambulance, police and emergency rescue squads were notified. Artificial respiration was given for a period of two hours, using an inhalator and two tanks of oxygen, before she was pronounced dead. On account of the pregnancy the prone-pressure method of artificial respiration was not given.

Necropsy performed eighteen hours after death showed no postmortem decomposition in any of the organs or tissues. She was a slender, colored woman, 5 feet, 2 inches in height; 115 pounds in weight. The abdomen was distended to the umbilicus and tympanitic

nails were cyanotic. There was considerable yellowish powder over the vulva and in the vagina. No blood was present in the vagina.

On opening the abdomen, the top of the uterus was at the level of the umbilicus and markedly tympanitic over its anterior surface.

As air embolism was suspected, the sternum was removed using the same technic as in Case I, avoiding the cutting of mediastinal vessels and the use of undue force. On opening the pericardium, the right side of the heart was greatly distended, ballooned out, and tympanitic on percussion. The left ventricle showed moderate rigor. Both inferior and superior vena cavae were distended and appeared to contain air bubbles.

The pericardial and chest cavities were filled with water and the heart showed a tendency to float. It was pushed back under the water and the right ventricle opened. Large bubbles of air under pressure escaped with a small amount of frothy, fluid blood. The endocardium and valves of the right side of the heart were normal and showed no evidence of hemolysis. The foramen ovale was closed. The left side of the heart was normal and the coronaries contained no air. There were no petechial hemorrhages in pericardium or pleura. The lungs showed considerable blood in dependent portions and only the slightest amount of terminal edema.

The inferior vena cava in its abdominal portion contained air bubbles and frothy blood. The intima showed no hemolysis.

Both ovarian veins were distended with foamy blood, and air could be seen in the veins

\* Vioform powder is a quinoline preparation.

of the broad ligaments especially in the upper portions.

The vagina was coated with a yellow powder,

uterine segment between the head of fetus and internal os. The pelvic measurements were normal.

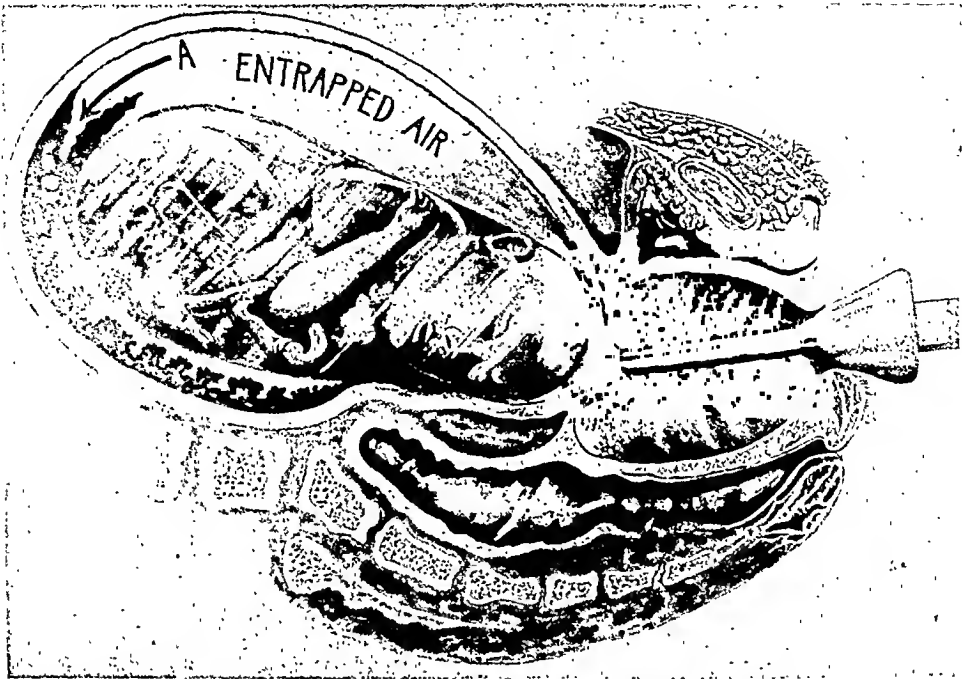


FIG. 5. Mechanism of fatal air embolism in Case 11. Note separation of fetal membranes from endometrium, and pocket of entrapped air beneath anterior wall of uterus; also torn and partially separated placenta at (A), allowing rush of air into maternal sinuses and uterine veins.

thickest over the vaginal vault and about the cervix.

On opening the uterus, a seven-month fetus was found, surrounded by intact amnion. The entire amnion, however, was separated from the uterine wall except at the placental site. Over the anterior surface of the uterus, there was an air space, 3 to 4 cm. in thickness, causing the tympanic note on percussion.

The placenta was attached to the posterior wall of the uterus in its upper part. Near its upper and left edge there was considerable hemorrhage in the placenta and it was partially torn by the dissecting entrapped air. This allowed air under pressure to rush into the open maternal sinuses.

On opening the amniotic cavity, it contained a male fetus, 14 inches in length (about seven months), in good state of preservation and showing no maceration or decomposition. Autopsy of fetus showed normal organs and no hemolysis.

The fetus was a vertex presentation and there was considerable powder in the lower

*Comment.* The stiff metal end of the insufflator used in this case must have rested against the soft cervix of the pregnant uterus and considerable powder and large amounts of air were blown directly into the uterine cavity. The rubber shield of the insufflator when held closely against the external genitals prevented the escape of excessive intravaginal air. The mechanics of what occurred in this case is shown in Figure 5.

#### SUMMARY

1. Two fatal cases of air embolism of the pulmonary variety, due to the use of common powder insufflators for the relief of pruritus vulvae are reported.

2. These insufflators are in common use, especially for the treatment of trichomonas infections and their main purpose is to dilate and smooth out the folds in the vagina so that the powder may be sprayed

on the mucosa. Their use, therefore, depends on the distention of the vagina with air through the vaginal outlet. This is maintained by the rubber shield or shape of the instrument and by holding the insufflator tightly against the vaginal outlet.

3. It is obvious, therefore, that the sudden blowing up of the vagina with air under excessive pressure is not without some danger and that fatalities may occur.

The engorgement of the endometrium around the menstrual period, open veins after uterine curettage, and the soft cervix of a pregnant uterus, all might favor air embolism, during such insufflations.

4. It is also reasonable to assume that very few of these catastrophies are likely to be reported and that perhaps some such deaths have been attributed to heart

disease or some other condition and never verified by autopsy.

5. It would seem, therefore, that such a method of treatment should either be given up, or modified, so that excessive intravaginal air pressure is not necessary to coat the vaginal walls with medicinal powders, a coating which is by no means uniform.

6. In the discussion of this paper,\* one gynecologist suggested that if a woman is put in the knee chest position, the whole vagina will immediately balloon out with a smoothing out of its folds, allowing the vaginal mucosa and the external genitalia to be sprayed or coated with powders without excessive air pressure.

\* Section of Obstetrics and Gynecology, The New York Academy of Medicine, December 26, 1944.



# REFRIGERATION IN GENERAL SURGERY OF LIMBS

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IT will be necessary to refer to current papers<sup>1,2</sup> for some theoretical and technical phases of this subject. The main points for the present purpose are that hypothermia of local tissues is safe and harmless under any reasonably intelligent management, and there is a choice of various degrees of temperature and use or non-use of a tourniquet to suit conditions. When refrigeration was first introduced for anesthesia in amputations, I expressed the belief that extensive uses for the method would develop. Notwithstanding the arbitrary delays, progress has been made by independent workers in this and other countries. This paper, therefore, will consist of an enumeration of the principal surgical uses of refrigeration known now, eight years after the first publication and four years after the first adoption of the method by Crossman. Examples will be taken almost entirely from the reports of other observers, one reason being to furnish evidence free from individual bias, and no known adverse reports will be omitted.

## AMPUTATIONS

Refrigeration has continued to find its widest employment for amputations in poor-risk patients. The advantages claimed in our previous publications<sup>1a</sup> need not be recapitulated. Out of the list of about fifteen, probably the most important are the freedom from shock and from post-operative pain, and the greatly reduced liability to sloughing, infection, thrombosis and other complications. The fallacy that shock can be prevented with spinal or any anesthesia other than refrigeration was remarked upon elsewhere.<sup>1b</sup>

The added feasibility and safety of low amputation levels with refrigeration deserves more notice. Amputations below

the knee being a matter for individual judgment, the question is mostly one of different levels in the thigh. Although refrigeration prevents operative shock at all levels, there is less systemic strain and weakness connected with the healing of a supracondylar amputation than when large muscle bellies are cut higher up; also a more efficient stump results. Mid- and high-thigh amputations still seem unnecessarily numerous in the literature, and most surgeons apparently have not emulated the Crossman record of practically exclusive low-thigh amputations. Refrigeration before and after operation has obviated danger from incisions through cellulitis or frank pus, and even if the wound must be left wide open the immediate and final results have been gratifying.

Although edema is beneficially inhibited, the low temperature and delayed agglutination often result in a slight accumulation of serum, as several surgeons have noticed. Often this is not incompatible with tight closure, but there is a growing habit of placing a very small gutta percha drain in each angle of an amputation wound, which may eliminate a few micro-organisms along with the serum and, if removed within a few days, scarcely interferes with primary union. This serous leakage may be regarded as due not to the refrigeration anesthesia but to the postoperative cooling. It need not result from refrigeration anesthesia if the subsequent cooling is omitted, and its occurrence can be expected if sufficient cooling is used after any other operative anesthesia. The benefits, in the control of pain, edema, infection, etc., as previously described, are such that cooling may actually be used with advantage after amputations under any kind of anesthesia, and Krieg<sup>4</sup> employs it also for abdominal and other operations.

While Neller and Schmidt<sup>3</sup> endorsed refrigeration for amputations, their exceptions in regard to young strong patients are discussed elsewhere,<sup>1d,2</sup> and their views on vasoconstriction are considered later in this paper. The theoretical objections of Large and Heinbecker<sup>5</sup> are sufficiently answered elsewhere<sup>1c,1d</sup> and are omitted from the present discussion, which deals only with actual experiences. Reasons have also been given for the belief<sup>1d,35</sup> that the suspicion of Richards<sup>3</sup> concerning tissue injury is a misapprehension based on inadequate and confusing evidence.

It has appeared instructive to compile a separate bibliography of writers<sup>3</sup> in various countries who have reported beneficial results with refrigeration anesthesia. Favorable opinions have been received in a larger number of private communications. The total number of amputations under refrigeration now evidently runs into thousands, and, as mentioned elsewhere,<sup>1d</sup> the absence of disasters or deaths is unique, just as the prevention of shock is unique, and seems to establish this as the safest of all anesthetic methods. At the same time two derogatory ideas are promulgated: (1) that refrigeration must be limited to carefully selected poor-risk cases (i.e., if patients appear too strong to die from shock they should be subjected to shock); (2) that all refrigerated tissues must be excised, a remarkable judgment in view of the multitude of reports of improved healing and reduced mortality.

The consensus of publications credits refrigeration with the following changes in amputation surgery: that the formerly large list of "inoperable" gangrene cases has ceased to exist; all patients of this class now undergo operation with a gratifying proportion of recoveries; and no institution can make such a claim unless it either uses this method or fails to receive cases of this type.

#### ARREST OF INTOXICATION OR HEMORRHAGE

One of our first problems in the City Hospital service was created by patients

who either refused amputation or were received under conditions which prevented obtaining immediate legal permission from them or their families. The advantages of packing infected gangrenous legs in ice were learned in such cases. Hyperpyrexia, delirium, unconsciousness and prostration are often thus relieved within twenty-four to forty-eight hours, so that operation becomes feasible. Likewise diabetic glycosuria and acidosis which resist huge doses of insulin in the presence of such an infection are transformed by the refrigeration so as to be quickly controllable with small doses. This method has been used and confirmed so extensively that it may now be called routine for a class of cases which were formerly hopeless but which now often turn out favorably.

The very scanty blood flow in arteriosclerotic legs favors the success of this plan. There is the further advantage of adding no risk or responsibility if operative permission is never obtained. If the infectious condition is particularly dangerous or the blood supply greater than usual, a tourniquet offers a means of stopping absorption absolutely. We early learned this way of obtaining the immediate benefit of amputation without the disturbance of operation; but it also entails the necessity of obtaining operative permission in advance, because a tourniquet applied to such a badly infected limb for any long time should not be removed. This means of stopping absorption may be considered in three forms.

1. The most primitive form is a simple tight tourniquet when no refrigeration is available. It may be used not only for arteriosclerotic or traumatic gangrene but for other infections, snake bite or any other condition that is dangerous enough to warrant sacrifice of the limb to save life. U. S. Army regulations endorse this method for wounds of blood vessels or other structures which make loss of the limb inevitable. The excruciating pain of the tourniquet must either be endured, or mitigated by huge doses of strong nar-



cotics, or preferably relieved by local procaine infiltration. Asphyxia of nerves terminates all sensation within a few hours. Such a tourniquet may be effective in stopping intoxication for days, and as the tissues soften and decompose a fresh tourniquet placed immediately proximal to the original one is better than merely tightening it. The initial pain, also infection and decomposition, are reduced in proportion as the limb can be cooled by cool air, running water or any other means. With a simple wound but not with a diffuse infection it may be feasible to save a limb after longer periods than surgeons have realized, namely, after twelve hours at average air temperatures, or shorter periods at tropical temperatures or longer times in proportion as cooling has been possible; and in forming such a judgment, shock, tissue devitalization and other dangers should be neither ignored nor exaggerated. Generally the method is designed as a temporary amputation, to serve until circumstances permit regular surgical amputation.<sup>6</sup> This method should have wider use; for example, in shock cases in which a day or two of delay may greatly reduce the danger of a thigh amputation. This time can be lengthened by simple cooling devices without actual refrigeration.

2. Refrigeration with the tourniquet controls pain, infection and decomposition, lengthens the time limits and serves most efficiently as a temporary amputation. The control of initial pain may be incomplete unless refrigeration can be applied prior to the tourniquet. Systemic intoxication can thus be held in check practically indefinitely. The final amputation is then performed proximal to the tourniquet, without removing it, and a higher tourniquet for the usual two or three hours serves for anesthesia. Since shock is prevented, attempts to save the limb may be permissible after periods of forty-eight hours or more, if there is no infection or only superficial infection; but in cases of diffuse infection animal experiments<sup>7</sup>

indicate that although the formation and absorption of bacterial products are stopped, the existing products evidently diffuse through the tissues, so that removal of the tourniquet after such a time as twenty-four hours results in fulminating local necrosis and systemic poisoning. These limitations do not apply to potentially infected limbs, even if they are full of dead tissue and dirt. The refrigeration prevents any massive toxin formation.

The maximum time limits of preservation under favorable conditions are undetermined. The longest human case was the one verified by Crossman, in which a necessary amputation of a boy's arm happened to be postponed until after forty-eight hours of refrigeration with a tight tourniquet. After amputation distal to the tourniquet, free circulation returned in the stump, which showed no lack of vitality or healing power. The much longer preservation of bloodless tissues experimentally, namely, fifty-four hours for animals' legs<sup>8</sup> and ninety-six hours for rats' tails,<sup>9</sup> did not represent maximal time limits; therefore it is theoretically possible that human limbs may be preserved still longer, presumably with various degrees of subsequent inflammation and fibrosis in the extreme instances. Although there happened to be no harm from the tourniquet in the case of the boy mentioned, it must nevertheless be remembered that this zone of pressure, which is also the meeting place of cold tissues and warmer tissues, is particularly vulnerable, so that the location of the tourniquet may prudently be changed two or three times in each twenty-four hours to reduce the risk of thrombosis in the longest ligations, without the need of heparin or possible surgical removal of a thrombus.

Hemorrhage holds a special position, as having been the chief indication for the use of a tourniquet heretofore. I have several times pointed out that mishaps and resulting fears have been due mostly to mistakes in regard to materials, breadth, temperature and other factors. Warming

the ischemic limb is the supreme blunder, but cooling it in no wise interferes with changing or loosening the tourniquet at any intervals the physician may think advisable. For those who fear prolonged ischemia it is possible, according to observations of Gratz mentioned elsewhere,<sup>1d</sup> to release the tourniquet at any desired intervals even in the induction of operative anesthesia. Refrigeration not only multiplies the safe period of single tourniquet applications, but it also saves tissue damage. Surgeons have been taught that they were doing their duty by releasing a tourniquet every half hour, but anybody who will continue this process very long on a rat's leg will notice what a severe inflammation results. Wounded tissues are more sensitive to such injury than any normal animal's leg, and this damage, previously ignored, is mostly prevented by refrigeration whether the tourniquet be used for a single long application or multiple short ones.

3. Whenever amputation is unavoidable and legal permission for it is assured, intoxication can be decisively halted by McElvenny's<sup>10</sup> method of freezing, which dispenses with a tourniquet. For example, a gangrenous foot may be treated by apparatus creating a temperature of 10°F. to a level below the knee. This "amputation by cold" has been continued as long as eight weeks, with the patient comfortable and gaining strength. The border between frozen and unfrozen tissues is marked not by a line of demarcation but by an ecchymosis about 2 inches wide. Surgical amputation is finally performed above the knee. By thus waiting until the best possible constitutional condition has been attained, McElvenny reports a series of amputations with primary healing in all but one and no deaths. The solid freezing may be regarded as essentially equivalent to a tourniquet with refrigeration. Under some military or other conditions, freezing of a limb in winter might conceivably be easy when controlled refrigeration or even a tourniquet might be

lacking, and this method might serve for most of the purposes mentioned under (2) whenever a limb is positively beyond saving.

#### EMERGENCY PRESERVATION AFTER TRAUMA

The classical example is McElvenny's case<sup>11</sup> of a man with both legs amputated near the knees by a railway train, who arrived at the hospital with a blood pressure of 30/0. The packing of the mangled stumps with ice radically controlled pain and infection, so that shock could be treated and strength built up sufficiently for successful surgical amputation, fifty-eight hours after the accident. At that time the tissues, full of dirt, were still entirely fresh and odorless.

Dziob and Brown<sup>3</sup> reported a less extreme case of traumatic amputation of one leg below the knee, in which pain, shock and hemorrhage were controlled. Miyakawa<sup>12</sup> treated a miner who was received in severe shock after a loaded coal car had run over his right upper tibia. Immediate surgery was limited to repair of ruptured bladder and urethra. The leg was packed in ice. After thirty-nine hours the strength had been built up so that a mid-thigh amputation could be performed in bed under refrigeration. Healing occurred by primary union.

Obviously, the customary bacteriostatic drugs and surgical technic are used as desired or possible. But refrigeration should not be withheld for want of sterile ice. The contamination already present in the average traumatic emergency is such that direct contact with any kind of ice does not add to the danger but enormously reduces it. A protesting surgical conscience may need to be taught that infection cannot develop in the dirtiest ice or snow that can be picked up on a winter street, but the devitalization and bacterial incubation which occur even during a few hours of transportation to the hospital are as important as they have been neglected. Drugs which inhibit bacteria do not alter devitalization. The use of unclean ice in

an unclean open fracture being nothing outrageous, the question of asepsis becomes important in proportion as the wound is primarily clean. The ordinary artificial ice blocks or cubes are not heavily infected, particularly with pathogens. They cannot harm a closed trauma, and an open trauma is not clean enough to be endangered by such ice. Sterile ice, therefore, is a luxury needed for truly sterile operations. It can be provided by special apparatus or improvised devices, or electrical refrigeration may be still better. The essential point, however, is that under the dirty conditions of the average traumatic emergency, refrigeration should never be delayed a single hour by objections to the quality of ice available. Proof is furnished by the actual treatment of the patients here described.

#### LONG PRESERVATION AFTER TRAUMA

Most striking are Mock's reports<sup>3,13</sup> of pelvic fractures with iliac or femoral thrombosis entailing gangrene of a leg. The dilemma was that the patient would die from a thigh amputation under the conditions of shock and visceral injury, and would also die if delay allowed the gangrene to develop. The solution was found by preserving the legs with refrigeration for two or two and one-half weeks. The complications in one case included cerebral concussion, severe chest injury, ruptured urethra, infected large hematoma of buttock, pneumonia, and empyema which ruptured into a bronchus and required emergency tracheotomy followed by rib resection. Recovery under such conditions is probably unparalleled. In Mock's opinion, amputation at any earlier time would have been fatal, and when performed at the end of two and one-half weeks it was at a lower level than ordinarily anticipated because of the development of collateral circulation.

The treatment described by Ottaway and Foote<sup>14</sup> is noteworthy because it was carried out not with ice but with apparatus improvised on board a destroyer on active

naval service. A shell fragment severed a man's femoral artery and vein 6 cm. below Poupart's ligament, passing behind the femur without injuring it and making an exit wound of 20 by 10 by 6 cm. The refrigerated leg was kept in good condition for twenty-eight days, when it was possible to transfer the patient for amputation, which was done successfully 10 cm. below the lower edge of the wound.

Bowers<sup>15</sup> described benefits from shorter refrigeration in cases of traumatic thrombosis of leg arteries in soldiers. The reports by Crossman<sup>16</sup> and associates, of preservation for two to six weeks in cases of femoral embolism, are here omitted because of the origin from our own group, but Crossman<sup>35</sup> refers to a private report of cases by Dr. I. M. Nachlas, of Baltimore, typified by the following example: A man was received in shock after a blast accident, with one hand blown off and the other extremely torn and fractured. The usual immediate amputation of both forearms would not have seriously endangered life, but, instead, both forearms were encased in crushed ice. The abdominal injuries required two and one-half weeks of treatment before finished surgery of the forearms was considered feasible. The stump of the one wrist was then amputated one inch above the lacerated skin line, and the remaining hand was restored to usefulness by reconstruction. The result was, in the words of the surgeon, that the patient was saved "from the horrors of no prehensile limb."

The excellent healing in all of these cases, in tissues refrigerated for periods running into weeks, furnishes one of several disproofs of the dictum that tissues which have been refrigerated even for two or three hours must be removed.

#### DÉBRIDEMENT

Reasons have already been given why refrigeration is the ideal anesthetic for amputation in cases of existing shock. Also, there will doubtless be ready agreement that amputation should not be

performed in the midst of critical shock, if limbs can be preserved by refrigeration so as to permit postponing the operation until the patient is in better condition. Similar rules apply to débridement.

In cases of deep wounds and fractures, a tourniquet can be combined with refrigeration for the brief purpose of anesthesia, without fear of harm even if serious infection is already present. Superficial cleaning and excisions may be feasible without a tourniquet.

When débridement can be well tolerated, the reasons for it remain fully valid, namely, the prevention of pain, infection, decomposition of dying tissues, and systemic intoxication and late shock. But the strongest believers in the causation of shock by fluid loss will be most strongly impressed by the added oozing which results from laying bare large surfaces or opening up penetrating wounds. This has, however, become one of the most regular and axiomatic surgical routines, because the omission of it involves worse consequences than the performance, even in shock. But the complete suppression of all these dreaded consequences by refrigeration establishes a new rule, namely, that with critical shock present or anticipated, nothing whatever should be done to increase shock. Much time and demonstration may be required before veteran surgeons will accept such a proposal in its full literal application in shock; namely, that mangled limbs full of dirt and shreds of clothing, perhaps with shattered bone fragments pressing on nerves, should be left untreated except for refrigeration, with or without a tourniquet according to the presence or absence of hemorrhage. The acute shock danger takes precedence in treatment. Blood vessels can be repaired within a few hours to permit removal of the tourniquet. Dirt, foreign bodies and setting of fractures can be left for days or if necessary for weeks, pending recovery from shock and visceral injuries, since tetanus, gas or other infections cannot develop in tissues that are sufficiently

cold. This rule for critical shock is implicit in the observations recounted in the preceding sections, but it is stated plainly to emphasize it for either adoption or controversy.

#### CRUSH INJURIES AND ARTERIAL WOUNDS

The English studies of the crush syndrome have partially identified it as a combination of ordinary shock with a special intoxication by products of damaged tissues, one such product being myoglobin which by forming deposits in the renal tubules contributes to the terminal uremia. Warming of the injured limb is harmful for obvious reasons. Conversely, cooling is included as part of the routine local treatment by English authors.<sup>18</sup>

The theoretical reasons are clear; namely, reduced temperature relieves pain, preserves tissues from decomposition, depresses local metabolism so that a reduced blood supply may become adequate, diminishes exudation, inhibits shock and retards toxic absorption. Although the possible benefits of immobilization by casts or compression by tight or elastic bandages are recognized, wounded tissues are still more sensitive than normal tissues to injury by pressure, so that refrigeration must be further considered from three standpoints: First, the low temperature may largely or wholly replace pressure treatment. Second, if pressure is to be used, it should be combined with refrigeration or, lacking this, with the lowest temperature obtainable by exposure to cool air, water or other available aids, because of the direct benefits previously mentioned and also because cold greatly reduces the injury of pressure, as proved by our experience with tourniquets and by re-interpretation of the experiments of Brooks and Duncan.<sup>16</sup> Third, the dangerous pressure arising from hemorrhage or swelling sometimes necessitates operation to split the fascial sheaths, and refrigeration may either obviate such an operation by reducing the pressure and asphyxial dam-

age or may provide safe and convenient anesthesia for the operation.

A tourniquet may be necessary under two conditions: (1) It is harmless for brief anesthesia for any deep operation on the limb. (2) A permanent tourniquet may be an immediate substitute for amputation of a hopelessly injured limb, as previously explained. Suggestions<sup>19</sup> of intermittent tourniquet applications, especially without refrigeration, must be viewed as a fallacious means of attempting to retard toxic absorption, just as in the case of snake-bite and for the same reason. Animal experiments prove that in shock due to tourniquet application or muscle trauma, any subsequent tourniquet application of long or short duration merely adds to the local and systemic damage; the tissue toxins evidently are not destroyed rapidly like strychnine but persist longer than any feasible time limits of ligation. Refrigeration can theoretically multiply these time limits, but in cases of such injury the benefits of low temperature seem to be sufficiently obtainable without the addition of prolonged tourniquet pressure.

Crush injuries sometimes damage important blood vessels. Also apprehension has been expressed that cold may add a deleterious vasoconstriction to the existing impairment of circulation in such a limb. There is a relation also to the arterial spasm which is known<sup>20</sup> to be caused not only by direct wounds of arteries but also by wounds near arteries or involving large nerves. Cohen questions the nervous reflex mechanism of such spasm and shows that procaine infiltration of either the local region or the nerve roots may fail to relieve it.

Physiologically, cooling of a limb induces vasoconstriction partly in correspondence with the reduced nutritive needs of the local tissues, but still more as part of a protective mechanism for maintenance of normal temperature in which a contraction of vessels over the entire body surface participates. Heating of other parts of the body neutralizes this reflex

action, and overheating of the body or of some limbs can dilate vessels of the entire body surface including the other limbs.<sup>21</sup> Therefore, if other parts are suitably warmed, the suggestion of Neller and Schmidt<sup>3</sup> that refrigeration anesthesia is contraindicated in such conditions as Buerger's disease appears theoretically improbable, and proof by definite observations one way or the other would be of interest.

The effect of refrigeration properly applied to an injured extremity is sedation. Pain and afferent impulses which excite spasm are abolished. In tissues which are sufficiently cold, the nerves cannot transmit and the smooth muscle cannot contract. Therefore, English writers are on a sound basis in recommending reduced temperature treatment for arterial spasm. If simple refrigeration fails to relax an existing spasm, there may be theoretical promise in using brief radical refrigeration with a tourniquet, trusting to the ensuing rush of hyperemia to open up the anesthetized artery, especially if heat is properly applied elsewhere. Instead of a contraindication, the advocacy of refrigeration as the best treatment for arterial spasm can be supported on two grounds: First, whatever the mechanism may be, the sedative action of cold may succeed even where procaine fails. Second, there is not only avoidance of added tissue injury by infiltration, but the refrigeration also preserves the vitality of the tissues which have been made ischemic by the spasm.

#### SHOCK

The work of Temple Fay and ourselves terminated the immemorial tradition of treating shock by warming either the entire body or the injured part. Clinicians<sup>22</sup> have noticed the decidedly lighter degree of shock produced by the same kinds of wounds in cold as compared with hot weather. The worst that has ever been concluded experimentally regarding general or local hypothermia is that it merely prolongs but does not save life in the most

hopeless degrees of shock. Only a moderate reduction of general body temperature is possible without harm; therefore, systemic hypothermia mitigates but does not prevent shock. There are theoretical reasons to regard the spontaneous tendency to fall of temperature in uncomplicated shock as a beneficial protective reaction, and recent experimental work<sup>23</sup> indicates that a certain proportion of lives are saved by treating such cases either in a cool environment with approximately normal body temperature, or with such slight reduction of rectal temperature (96 to 94°F.) as may be tolerated without shivering or discomfort.

Reduction of local temperature can be most radical and therefore most powerful. The specific relation of temperature to the shock process is proved by the fact that cold applied before and during injury appears to prevent shock completely,<sup>24</sup> and it is the only agency that has this power. In turning from prophylaxis to practical therapy, success necessarily varies with the degree of shock and the length of delay before beginning treatment, but the demonstration<sup>25</sup> of life-saving benefits within certain limits has been verified by later writers.<sup>26</sup>

The principal other local treatment for shock is pressure with casts or bandages. This treatment can undoubtedly save life under certain conditions, but it also involves dangers of necrosis and bacterial incubation. Cold may sometimes be an advantageous substitute for pressure, but there are no more than technical problems in combining the two. There is no valid excuse for warmth in a shock case. On the contrary, cold as usual inhibits pain, swelling, infection and tissue devitalization and greatly reduces pressure injury. Therefore, if refrigeration is not possible, the limb with or without pressure should be kept as cool as available means permit.

#### GANGRENE

Three widely different conditions are jumbled under this heading:

1. Arteriosclerotic or diabetic gangrene often permits of nothing better than the shockless amputation previously described. The test of any conservative treatment is whether it can save a leg which would be lost without such treatment. All the previous mechanical attempts have seemed to me to do harm in critical cases by violating the principle of surgical rest. Radical chilling checks pain, infection and necrosis for a longer or shorter time, depending largely on how high up the leg the refrigeration is carried, but this temperature also prevents healing. The ideal temperature is an intermediate one which will control the pain, retard infection and prevent necrosis by reducing the local metabolic needs within the capacity of the scanty blood supply, while permitting healing at a correspondingly slow rate. The practical benefit of this method seems to be limited to avoidance of the harm that is often done by other methods; no positive cure in an otherwise hopeless case is known. The most promising plan seems to be to expose the affected region to the coolness and dryness obtained with a simple electric fan or a special air chamber, keeping the skin temperature perhaps between 20 and 30°C. (according to comfort) for the hypothermic benefits mentioned, while the patient is kept warm and the affected leg is heated. In a case of beginning discoloration of toes, the cooled area will include the cyanotic anterior portion of the foot, while an accurately controlled heating device is applied from the thigh down below the ankle and maintained at the highest safe temperature, in order to promote hyperemia. Such a treatment continued for weeks offers probably the best hope of saving an extremity that can be saved, but failures will necessarily be numerous and constitutional treatment may be a more important factor than the local treatment.

2. In the acute gangrene following thrombosis, embolism or other closure of main limb arteries, the prognosis also depends on the state of the arteries as

well as the location of the obstruction and other variables. A decisive factor in gangrene is sometimes a functional spasm of collateral branches about the region of organic obstruction of the main artery. It is only desired to emphasize a rational management of temperature, for which adequate experience is still lacking. The immediate crisis demands radical chilling as near to freezing temperature as possible, for the best control of pain, shock, thrombosis and necrosis. The belief has already been expressed that suitable warming of the rest of the body can assure a full or actually increased blood supply to the threatened limb and prevent vasoconstriction, especially of the deep vessels. Cohen has emphasized the contraction of superficial vessels as an actual aid to the filling of the vitally important deep arteries. The influence of the local cold in preventing vasospasm, thrombosis or degeneration of vessel walls as well as other tissues is the probable reason for the development of an unusually free collateral circulation, which in the opinion of Mock and other surgeons has permitted the final amputation to be made at a lower level than ordinarily anticipated. If lesser degrees or more distal location of the circulatory block offer a chance of saving the limb instead of amputating, it is desirable that the temperature should be raised as gradually as necessary but as rapidly as is safe, and here experience is lacking and guidance must be sought in the signs in individual cases.

3. Certain other conditions of thrombosis or necrosis are dominated by infection. Theoretical benefits of cold in thrombophlebitis, through the double action of inhibiting both bacterial growth and thrombus formation, were apparently illustrated in a single case of the City Hospital surgical service, but no experiences by others have been published and real proof is therefore awaited. The gravest infections, such as spreading cellulitis and gas gangrene, offer a field for refrigeration as follows:

If amputation appears inevitable, a tourniquet with refrigeration can serve the purpose temporarily, as previously explained. The refrigeration should extend above the tourniquet to the groin or axilla, as an aid against organisms which may be invisibly present. Recovery in a desperate case convinced Ferguson<sup>27</sup> that refrigeration is the best anesthetic for amputation in gas gangrene.

Refrigeration without a tourniquet is advisable if the limb is to be saved. Besides the usual checking of bacterial invasion, toxic absorption and tissue necrosis, a special value in gas-forming or other anaerobic infections is promised by the high oxygenation which is indicated by the bright color of blood and exudates at low temperature. Efficient refrigeration soon changes dark foul exudates to an odorless discharge with the clear pink of oxyhemoglobin. Cases thus treated with great or life-saving benefit are known through private communications and are expected to be published.

#### COLD IN TREATMENT OF LESIONS DUE TO COLD

Frostbite is caused by freezing or excessively long exposure to non-freezing dry cold, while "immersion foot" results from prolonged wetness at temperatures more or less above freezing. Rapid or excessive warming is the worst possible treatment for either condition. Radical refrigeration is theoretically irrational in treatment, since it is unnecessary and interferes with healing. The temperature should be low enough for the usual benefit in controlling pain and neurovascular disturbances and preventing necrosis by keeping metabolic demands within the circulatory capacity; but at the same time it should be as high as possible to favor healing. Webster<sup>28</sup> and co-workers have credit for priority in the introduction of this treatment, and they also furnished the strongest evidence that moderate cooling with an electric fan or otherwise can not only relieve symptoms but also save many



amputations. Greene<sup>29</sup> recommended lower temperatures of 2 to 5°C. in his special chamber cooled with solid carbon dioxide, and Davis<sup>30</sup> and associates adopted this method. The negative report of this latter group may be explainable by two facts: (1) the refrigeration was unduly radical; (2) the high altitude frostbite which they treated is in their own opinion different from frostbite at less extreme temperatures, and the more acute and localized destructive process may include less of the functional derangements which respond to hypothermia.

Although the optimal degree and duration of temperature reduction may vary in different types of injury and in different individual cases, the anticipated theoretical benefits of dry cooling are confirmed by a convincing unanimity of authors<sup>31</sup> who favor skin temperatures between 60 and 80°F., and hypothermia is accepted as a standard treatment especially in Canada and England.

#### REFRIGERATION FOR BURNS

Burns are particularly favorable for this treatment<sup>32</sup> because (1) their comparative superficiality makes them accessible to refrigeration not only on the limbs but everywhere in the body; (2) refrigeration offers a combined control of pain, shock, infection, toxic absorption and tissue devitalization such as is unmatched by any other treatment. While it can largely obviate the need for other treatment, it can also readily be combined with practically any other treatment. Simultaneous systemic treatment is taken for granted in the following discussion, and compressive or occlusive dressings can be associated as mentioned under the topic of shock.

The changes in procedure are nevertheless as radical as the benefits claimed, and they include the following:

1. The usual cleansing and débridement are prohibited, and the surgical conscience will again be shocked by the advice to leave dirt undisturbed. Long ago, Harrison

and Blalock<sup>33</sup> proved that débridement of burns intensifies shock and increases mortality, but, just as in the case of mechanical wounds, the knowledge remained theoretical because the omission of the added injury was followed by worse consequences. In addition to this systemic danger, cleansing and débridement are omitted because they waste time and particularly waste tissue.

2. The only exception is such a removal of dirt as may be incidental to an emergency treatment; e.g., the best immediate treatment for a burn is to plunge it into ice-water or even cool tap water, or elsewhere on the body ice should be applied with no delay. Not only are pain and inflammation relieved but the subsequent healing is helped. Some large industrial establishments already have rules and facilities for this treatment, in advance of conservative hospitals.

3. Formal treatment begins with the application of a thin layer of greased gauze, bacteriostatic ointments having no proved superiority over simple petrolatum for the purpose. This purpose is protection with a minimum of insulation.

4. Radical refrigeration is applied outside the gauze, reducing the skin temperature to a few degrees above freezing if possible. Not only does this prevent pain and the other disturbances mentioned, but also an existing intoxication with hyperpyrexia and prostration may be relieved within twenty-four hours. This reduced temperature may be obtained with ice or bare ice-bags, but they are extremely inconvenient and uncertain in comparison with the Therm-O-Rite refrigerating blankets or air chamber. It must be recognized that the larger the burned area, especially on the trunk, the greater is the difficulty in preserving normal body temperature by heat applied to unburned regions, and in the most extreme cases a compromise may be unavoidable in the use of a less than optimal degree of cold.

5. The crisis of shock and intoxication is maximal for only one to three days.



Thereafter the hypothermia is modified in proportion to the danger. Skin temperatures between 60 and 80°F. may have to be continued for a number of weeks for reasons previously stated. Any higher temperature permits a return of fever and intoxication, and any unnecessarily low temperature hinders healing.

6. The routine changes of the greased gauze are painless under refrigeration, and the original dirt comes away automatically and harmlessly. A tedious operating-room type of asepsis, such as is advocated in some quarters, is unnecessary because the temperature controls infection. With proper equipment the nursing demands are minimal.

7. The constitutional condition of such patients is transformed not only by the direct relief from intoxication but also by the freedom from the usual narcotics, with consequent benefits to nutrition and strength. Locally, the regeneration of tissue and reduction of the need for skin grafts are beyond precedent, because of the improved recovery of partly devitalized tissues at the reduced temperature, and furthermore because of the avoidance of the destruction of such tissues by the usual débridement.

Although the general idea of skin temperatures of the order of 70 to 80°F. was accepted by Pickerill and by Rossiter,<sup>32</sup> my proposal is new in most of the features described above. An exception to the rule for this paper must be made, because examples of the treatment can be found only in records published from the City Hospital; namely, a few cases from Crossman's service<sup>34</sup> and a single outstanding treatment by Kross, of which descriptions<sup>35,36</sup> and photographs<sup>2</sup> have been published. The desired wider trials have thus far been unobtainable.

#### MISCELLANEOUS USES OF COLD

This review need not include the common use of ice-bags or other cold applications, Fay's artificial hibernation, or the

dermatological uses of the selective destructive action of carbon dioxide snow. Incidental to this last method, statements that the Guinea worm is killed by brief freezing which does not harm the surrounding skin may have some present interest. Other ways to take advantage of the possible sensitiveness of tropical parasites to cold have been only slightly explored.

Ebin,<sup>37</sup> having proved that the most delicate human tissues are unharmed by freezing with solid carbon dioxide for one minute, proposes this method in combination with cautery for hemostasis in liver and brain operations.

H. E. Mock, Jr.<sup>38</sup> recommends two hours of chilling with bare ice-bags as an improved anesthesia for taking skin grafts. Theoretically, it would appear that this anesthesia which eliminates infiltration, together with the preservative influence of low temperature during and after operation, should find wider uses in plastic surgery.

Mention is made elsewhere<sup>1d</sup> of some initial trials of refrigeration, with and without tourniquet, for orthopedic surgery, a field in which some of the most valuable applications will probably develop.

The simple application of ice-bags before and after intramuscular injections of penicillin was found by Trumper and Hutter<sup>39</sup> to delay absorption so that effective bacteriostatic levels in the blood could be maintained by two or three instead of eight to twelve injections in twenty-four hours. Presumably, absorption of heparin could likewise be delayed. Though the emulsion form may prove preferable for most purposes, the possibility suggests itself that, since the major uses of refrigeration are associated with either thrombosis or infection, these technics may be conveniently combined.

Yudin<sup>3</sup> mentions experiments in which refrigeration protected rabbits against absorption of lethal quantities of mustard gas. A recent newspaper article described a case in which a person stung by a scorpion

applied ice and escaped all symptoms. Theoretically, there is little doubt that ice offers the most effective treatment for spider bites, bee stings and the irritation from mosquitoes and other insects. Refrigeration as a palliative or curative treatment for rhus poisoning remains to be tried. It can temporarily stop the itching of eczema but a permanent benefit is unproved.

Within the past few years, if opportunity had permitted, I would have repeated the former experiments with snake venom,<sup>40</sup> which were based on the mistaken principle of blocking absorption with a tourniquet. Increased appreciation of the efficacy of refrigeration without a tourniquet has created the impression that packing in ice should be an important part of the treatment of the average snake-bite, because it will control pain, reduce both local swelling and tissue damage, retard absorption and promote the serous flow with incision and suction, without doing any harm.

Mention has been made elsewhere of the obvious inference from the experiments of Blakemore, Lord and Stefko that human legs which have been either partially or completely severed by trauma can be repaired or restored after one to several days of preservation by refrigeration. Brooks and Duncan, whom these authors wrongly attempted to credit with priority in refrigeration, have interpreted their own experiments with emphasis on injury from cold, therefore, the principle employed by the Blakemore group rests still more definitely upon my earlier work.

Embolism or thrombosis of limb arteries offers a larger and simpler field for application of this principle. I have described elsewhere<sup>1a, 1b</sup> the proposed treatment by refrigeration without or preferably with a tourniquet, with the added suggestion of a plastic method for arterial repair. This technic for lining a segment of artery with a vein may prove faulty, and any method will doubtless require trials and failures before it is perfected, but the basic idea

of restoring endothelium in the same manner as epithelium is restored by a skin graft appears worth the effort of those who have facilities.

#### REFRIGERATION IN MILITARY SURGERY

During the past years I have repeatedly urged this as the most important and extensive immediate demand for refrigeration. Running through the list, from major amputations in weakened patients down to the minor and speculative developments, the applicability to war casualties must be apparent to anyone.

Yudin's experience of 120 amputations, together with his high authority in Russia, lends weight to his conclusion that refrigeration for military surgery "is highly recommended for use at the front as well as at the rear." Lobachév's large experience with civil trauma was confirmatory.

English authors now refer to refrigeration as a routine procedure, and Learmonth,<sup>18</sup> with reference to the preservative and bacteriostatic effects, writes that "the principle has been put to material use in the present conflict." The Canadian and English development of the hypothermic treatment of frostbite and immersion foot has already been discussed.

In the United States the unanimous and enthusiastic support of civilian users of the method contrasts with the official negativism. Much credit is due to the individual medical officers who have taken up the method on their own initiative and at their own risk. A review of the preceding list of beneficial uses will illustrate the consequences of the official failure to provide general instructions and equipment for the method.

1. For amputations the use has been limited to base hospitals, as reported by Shaar and associates,<sup>3</sup> or to veterans' hospitals. There is no reported use of this shockless method for badly shocked soldiers near the front.

2. There are no records of controlling dangerous local infection and intoxication by this means.

3. McElvenny's case<sup>11</sup> was published in 1941, but there is still no report of a dying soldier being given the benefit of such treatment.

4. Mock's first experience was published prominently in 1943. If Ottaway and Foote were able thus to save one sailor with improvised apparatus late in 1944, how many other lives have been unnecessarily lost?

5. There is not a single record of saving a limb of any fighting man from amputation by the method described by Nachlas.<sup>17</sup>

6. Crushed or mangled limbs and arterial wounds are treated with cold in England. The case report of Taylor and Tondreau,<sup>41</sup> showing skillful use of every other method, indicates the general lack of instructions on refrigeration in the armed forces.

7. The absence of mention suggests the inference that the latest information on reduced temperature is not utilized in the military treatment of shock, either alone or in combination with pressure. There must inevitably have been a host of instances comparable to the reported death of a war correspondent on an operating table.<sup>1b</sup>

8. The favorable results described by Bowers<sup>15</sup> in four soldier patients in this country have apparently not been extended to traumatic thrombosis cases from the fighting fronts. Ferguson's rare example of refrigeration treatment of gas gangrene evidently depended on individual initiative.

9. There would have been no chance even of trying hypothermia for frostbite if the work had not been done in Canada and England. Private information indicates that, at least in some important centers, this experience is still neglected in the treatment of immersion foot in American soldiers.

10. Other newspaper accounts of an admiral who is enveloped in flames, who afterward is able to help in the handling of a fire hose, who in bed hours later expresses solicitude for a guest, and who dies the next day, seem to leave little question of the diagnosis of burn shock.

If any special reasons made the outcome in this notable case unavoidable, there must be a host of other patients untreated with refrigeration on ships or in hospitals well supplied with ice. A similar stagnation in regard to the stereotyped plasma treatment of such cases is criticized elsewhere.<sup>1b</sup>

11. In several papers, mention has been made of the consequences of the long artificial delays in the development of this work and the continued institutional and official opposition. The complete stopping of the research for the past year is an added reason why this paper had to be based on observations by others, at a time when progress is so urgently needed along the many lines here suggested and along other lines.

12. Excuses of lack of refrigerating facilities near the fighting fronts are answered by the winter battles, the availability of ice or electricity on ships and near most fronts and in military hospitals, the heavy refrigerators provided for icing of food and drinks and the naval barges to supply icecream in the tropics, and the complete lack of interest in a light portable refrigeration unit for surgical use. This failure is chargeable not to the Army or Navy but to the special conditions explained elsewhere.<sup>1d</sup>

The evidence should be reviewed in steps. Are the reports on refrigeration authentic and credible? Are there casualties in war comparable with the civilian cases in which lives or limbs are said to have been saved by refrigeration? Is the aggregate number of such military cases to be counted in thousands or tens of thousands? Facts should be gathered and doubts settled rapidly on such simple questions in the emergency of war. What shall be the judgment on the total interdiction of adoption, trials and research progress during four years of mounting casualties?

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CHRONIC cystic mastitis is believed to be due to relative excess of the estrogens, producing abnormal duct proliferative activity. While estrogenic treatment has been generally recommended, it does not seem rational unless the dosage is sufficiently large to bring about pituitary inhibition.

From "Textbook of Gynecology" by Emil Novak (The Williams and Wilkins Company).

# POSITIVE PRESSURE RESPIRATION IN THE TREATMENT OF ACUTE PULMONARY EDEMA\*

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THE occurrence of pulmonary edema is generally considered to indicate a fatal outcome, whether it takes place in the course of respiratory or circulatory disease. Since a therapeutic procedure has been developed which is frequently effective in terminating this condition, and since its application is at present little understood, the detailed reports of the following cases were thought to be of interest.

Meltzer,<sup>1</sup> in 1878, stated that pulmonary edema resulted from a dysproportion between the ability of the left ventricle and that of the right ventricle to expel synchronously the same amount of blood. In 1909, Emerson<sup>2</sup> discussed this subject and showed that the edema produced in rabbits by intravenous injection of adrenalin was remedied by intratracheal distention of the pulmonary tree. Moore and Binger<sup>3</sup> demonstrated that congestion and edema of the lung could be accentuated by a narrowing of the trachea which caused obstruction to the inspiratory cycle whereby a negative pressure was created. This was later confirmed by Kernan and Barach<sup>4</sup> who produced a similar condition in animals who inspired against a negative pressure.

The effectiveness of combating acute pulmonary edema by positive pressure respiration has been demonstrated repeatedly by Barach and his colleagues (1935 to 1944). The principles on which the administration of positive pressure are based, the methods by which it is applied and the pertinent literature have been described in these publications<sup>5-8</sup> and need not be extensively reviewed here.

A brief summary of the physiological basis for the treatment may be outlined as follows:

1. The specific effect of inhaling a gas under increased pressure is to decrease the pathologically elevated negative intrapulmonary pressure in cases of obstructive dyspnea, since during the inspiratory cycle a heightened negative pressure tends to promote oozing of serum from the pulmonary capillaries. Breathing a gas under a pressure of 6 to 10 cm. of water decreases the negative intrapleural pressure during inspiration and relieves inspiratory dyspnea.

2. The lumen of the smaller bronchioles is less constricted during inhalation of an atmosphere under positive pressure.

3. The increased intrapulmonary pressure diminishes the accumulation of blood in the lungs by exercising to a variable extent a retarding effect on the entrance of blood into the right heart.

4. The inhalation of a gas under positive pressure exerts a direct opposing pressure on the pulmonary capillaries which tends to retard the outlet of serum from them, opposing in a direct way the increased hydrostatic pressure in the pulmonary capillaries. In cases of left ventricular failure the factor of diminishing the entrance of blood into the heart would tend to reduce pulmonary congestion and in that way make more equal the output of blood from both ventricles and give the left ventricle a smaller volume of blood with which to work. In this sense the procedure would be similar to phlebotomy or tourniqueting the extremities. In the absence of circulatory failure the

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direct physical pressure on the walls of the pulmonary capillaries would be the crucial influence, in addition to the increase in the lumen of the tracheobronchial tree. Positive pressure respiration has been given continuously in a hood apparatus constructed for this purpose, in which a pressure of 3 to 6 cm. of water is maintained both during inspiration and expiration.<sup>6</sup>

In addition, a closed circuit mask apparatus has been described for the same purpose.<sup>5</sup> A simpler method of applying positive pressure is available in which expiration is conducted either against a constricted orifice in the mask or through 2 to 6 cm. of water, the expiration being let off into a glass tube inserted in water to the desired level.<sup>8</sup> The closed circuit hood or mask apparatus is more effective and has the advantage of diminishing or relieving dyspnea; the mask which provides positive pressure during expiration is simpler and has also been shown to be efficient in obtaining the clearance of moisture in the lungs. The latter method requires the cooperation of the patient to some extent but this is generally obtained without difficulty. In the absence of any apparatus for producing positive pressure the cooperative patient may be instructed to exhale with the lips around some object which has a small bore opening, e.g., a cigarette holder. In this way there will be a modified barrier to exhalation which will produce a positive back pressure on the pulmonary alveoli. Similarly, the tired runner after great physical exertion or the excited person after a close brush with danger will produce a positive intrapulmonary pressure automatically by the simple and spontaneous act of puffing out the cheeks and closing the oral orifice in such a way that exhalation is impeded passing through the lips. This, in turn, produces a dilatation of the bronchial tree, allowing more oxygen to be absorbed by increasing the absorbing surface of the alveoli and results in a better physiological adjustment to altered physical states produced by oxygen want.

The following case of acute pulmonary edema may have had its etiology in part in a dysproportion between the output of the two ventricles and in part because of respiratory depression, which may have caused changes in permeability of the pulmonary capillaries:

S. B., age twenty-five, a physician, very obese, was admitted on February 16, 1942. The admission diagnosis was varicose veins of lower extremity, bilateral. He weighed 220 pounds. His past history was concerned mainly with varicose veins since the age of eighteen. He had scarlet fever at sixteen years. His family history was irrelevant.

Physical examination showed lungs clear and resonant throughout. Cardiac status and abdomen were normal. Blood pressure was 132/80. On the lower extremities were general varicosities with incompetency of the internal and external saphenous veins and those of the foot and about the ankle (bilateral). There was slight edema of both ankles. Reflexes were normal. The blood count showed 5,220,000 red blood cells; hemoglobin 12 per cent; white blood cells 8,900; urine negative.

It was decided to operate on his veins and the patient chose a general anesthesia. The usual preoperative sedation was given; i.e., morphine sulfate, gr.  $\frac{1}{4}$ , and scopolamine, gr.  $\frac{1}{150}$ . The patient, who was a doctor, undertook to prescribe for himself and, it was elicited later, took many doses of barbiturates during the night and before the operation. He reached the operating room in a somnolent condition which was not considered unusually severe. The anesthesia (cyclopropane-oxygen) was started at 11.35 A.M., February 17, 1942. During the anesthesia, his condition was reported as satisfactory. Shortly after the anesthesia was discontinued, at 1.10 P.M., the respiratory rate decreased rapidly to eight per minute and the patient became cyanotic. Oxygen was administered by face mask for forty-five minutes before he was removed from the operating room, and oxygen was then discontinued. On the journey to his room the respiratory rate decreased again and on arriving, cyanosis was marked. Oxygen by face mask was resumed. Metrazol, 1 cc., was administered by vein at 2.30 P.M., one hour and thirty minutes after the first depression of respiration, without noticeable effect. Again

at 3 P.M., 1 cc. of metrazol was administered. At 3.45 P.M., he ejected pinkish, frothy sputum. Atropine, gr.  $\frac{1}{150}$ , was given by hypodermic. Metrazol was given six times after this and stimulated respirations somewhat but also "made him sit up and fight." During all this time the patient was cyanotic and unconscious and the pulse was rapid. Caffeine, gr.  $7\frac{1}{2}$ , was injected intramuscularly with little effect. The best stimulant to his respiration was found to be the application of aromatic spirits of ammonia to his nose.

A portable x-ray of his chest at 3.30 P.M. showed a diffuse, patchy atelectasis of both lungs. The marked cyanosis continued; oxygen therapy by nasal catheter, mask, and oxygen tent did not change it significantly. The patient's blood pressure remained constantly at a satisfactory level. A bronchoscopy at this time was considered necessary and the following findings were reported: "Pre-operative diagnosis: Massive atelectasis with pulmonary edema, bilateral, diffuse. No anesthesia (patient unconscious). A 7 mm. Jackson tube was passed. The entire bronchial tree of the right and left side was filled with a serosanguineous fluid but immediately upon introducing the bronchoscope into the right main stem, the patient coughed and a large quantity of this fluid was expelled through the tube. The right and left lung fields were aspirated of this fluid." After the bronchoscope was removed the patient continued expelling the pinkish fluid in moderate quantities. There were no mucous plugs. Following the bronchoscopy, the patient's condition was worse; cyanosis was marked, breathing was stertorous and the pulse was of poor quality and rapid. Oxygen, 100 per cent, was tried by mask but it had no apparent effect on his cyanosis. Unconsciousness at this time was profound. There were no reflexes of the pharynx or larynx.

At 4.40 P.M., approximately three and one-half hours after the anesthesia was stopped, and his present difficulties began, anesthesiology consultation was requested and positive pressure respiration with 100 per cent oxygen was applied. Due to the extremely poor condition of the patient, the meter mask with positive pressure attachment was not employed to avoid the delay incident to obtaining it. Instead, an ordinary anesthetic mask with bag attached was rapidly strapped to his face with the pharyngeal airway in place and 100

per cent oxygen was run in under the pressure of the administrator's hand. This was equal to much more than the intrapulmonary pressures usually prescribed; i.e., 3 to 6 cm. of water. (The pressure was later estimated to be as high as 25 cm. of water.) After five minutes of this treatment, the cyanosis which, despite oxygen by face mask, catheter and tent, had persisted for three hours or more completely cleared and his color changed to a healthy pink. The edematous fluid from his lung did not well up anymore. After thirty minutes of oxygen under pressure the anesthetic mask was removed and the ordinary oxygen mask substituted without pressure; the cyanosis almost immediately returned and the pulmonary edema recommenced. Accordingly, oxygen under pressure was again applied and the cyanosis cleared as well as formerly and the pulmonary edema also within five minutes.

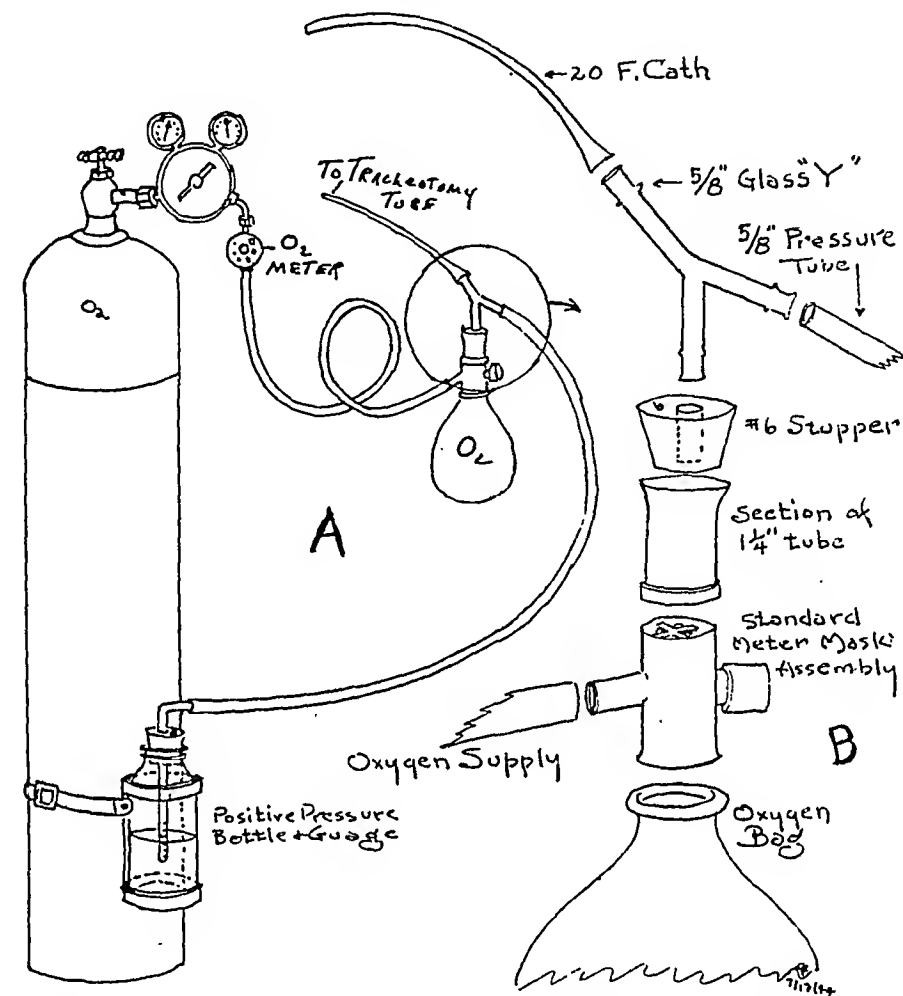
Oxygen under pressure was continued until 6.35 P.M., when the patient regained consciousness, asked for water and drank two ounces of it. Blood pressure was then 68/40 and his pulse was of poor quality. More cardiac stimulants in the form of caffeine and adrenalin were administered with moderately good response. At 8.45 P.M., the patient was fully awake; blood pressure was 85/60, pulse was 100 and there were moist râles at both bases. Heart sounds were good, his general condition better and there was still some cyanosis at the nail-beds, on discontinuance of pressure oxygen.

Oxygen therapy, without pressure, was continued during the night. The next morning, the patient was completely recovered in appearance. The chief complaint was soreness of throat, larynx and chest and an occasional mucous, blood-tinged cough. Physical examination: pupils reacted to light and accommodation; fundus normal; pharynx red; lungs—percussion note good, no fluid, free of wheezes and rhonchi; heart not enlarged, sounds good, A-2 three plus; pulse pressure still high (110/50). The patient still became cyanotic on coughing and oxygen was continued. Ear, nose and throat consultation the day after the operation showed the pharynx and epiglottis red, vocal cords red, tracheal mucous red. Opinion: acute pharyngo-laryngo-tracheitis. X-ray the same day (February 18, 1942) showed: "Considerable improvement. Aeration is well marked in the upper halves of both



lungs. There is still considerable diminished aeration in the rest of the lungs especially the middle thirds. There are no dense or atelectatic

not as tight. He expectorated a yellow mucus and the patient's condition was better. X-ray on this day showed a bronchopneumonic



### 100% Oxygen and Positive Pressure to Tracheotomy

FIG. 1. A, schematic representation of apparatus used in Case 11; B, details of the apparatus.

patches in the chest at the present time." Physical examination on the same day showed a diffuse, fine wheeze in the chest (asthmatic wheeze throughout lungs developed today. Relieved by adrenalin.) Sulfathiazole was given by mouth. His general condition was satisfactory except for chest wheeze; respirations 36, pulse 96.

The patient's condition slowly improved every day. Oxygen without pressure was given part of the day as long as tolerated. His cyanosis did not return and the patient was active and talking. The following day, February 20, 1942, physical examination showed the wheeze

process on the right lower lobe; the rest of the chest was well aerated. The temperature course which showed a rise to 100.6°F. following the operation dropped to normal at night and the next day rose to 102.8°F. It again dropped to normal within twelve hours but quickly rose to 102°F. on the second postoperative day. The fever temperature became gradually lower and by the fifth postoperative day was normal. The pulse reached a high of 120 in three days and gradually returned to normal. Respirations were 22 to 32 for the first three postoperative days and then returned to normal. Physical examination on February 20,

1942, (three days later) showed that the tightness in the chest was less, there was less cough and no reddish sputum. The sulfonamides were given for the pneumonic process and the patient responded favorably so that on February 23, 1942, he showed progressive improvement. X-ray demonstrated aeration complete throughout the entire left lung. There was still some infiltration at the right base. On February 24, 1942, which was seven days postoperatively, the chest was clear, the patient very much better with no cyanosis, no dyspnea, pulse normal and blood pressure 138/80. The following day his general condition was excellent and continued so until February 27, 1942, (ten days after the onset of his trouble) when he was discharged from the hospital.

#### COMMENTS

Pulmonary edema developed in this patient probably in part as a result of an unequal emptying of the right and left ventricles. Welch,<sup>9</sup> in 1878, explained this mechanism as due to an excess of blood in the pulmonary circulation, following a weakness of the left ventricle which impaired pulmonary venous drainage while the right ventricle performed normally, sending a steady volume of blood to the lungs. This resulted in an engorgement of the pulmonary capillaries with a consequent leaking out of red cells and later fluid into the alveoli. The anesthetic agent (cyclopropane) although not entirely free from pulmonary irritation, is, nevertheless, considered a non-irritating agent. It was believed that the self-medication by the patient which aggravated the respiratory depressing action of the cyclopropane played the major rôle in the production of the mechanism that caused the difficulty. The respiratory depression with the ensuing atelectasis and anoxia may have increased capillary permeability. The failure of oxygen therapy without pressure (which was used for two hours) to clear up the cyanosis indicated that the alveolar spaces filled with fluid did not allow an adequate pressure of oxygen to come in contact with the alveoli. When oxygen was administered under a high pressure

the capillaries of the lungs ceased to pour out serum and edema stopped. Barach<sup>10</sup> states: "The mechanism appears to be a direct physical force exerted on the external wall of the capillaries counteracting increased internal hydrostatic pressure in the capillaries and at the same time the elevated intrapulmonary pressure retards to a variable extent the flow of blood into the lungs." The escape of serum from the pulmonary capillaries having been stopped by the increased intrapulmonary pressure, oxygen then came into contact with the absorbing surface of the alveoli. The removal of anoxia to the brain was followed by restoration of consciousness. The long period of unconsciousness was, of course, due to the anoxia and not to the prolonged effect of the anesthetic agent.

Barach,<sup>10</sup> for the sake of simple illustration, had compared the application of air pressure to the lung to that of finger-pressure on the oozing surface on the outside of the body. The oozing of blood from body surfaces is controlled by pressure and similarly oozing of serum from pulmonary capillaries may be controlled by pressure when it is applied by means of a gas (oxygen) which, at the same time, sustains life. That this method was efficacious in stopping the edema in this patient was well demonstrated by the fact that the edema immediately started after the pressure was removed and was again controlled on the resumption of pressure.

Pulmonary edema resulting from obstruction of the air-way is a not uncommon occurrence. The edema resulting from respiratory obstruction is induced by the production of negative intrapulmonary pressures which result from the effort to inspire against a closed or partly closed orifice. The expanding thoracic cage attempting to draw air past the obstructed upper airway produces a direct suction on the capillaries of the lung resulting in a transudation of serum and blood cells from the vessels into the air spaces. There develops here also a deranged

cardiac rhythmicity resulting in an unsynchronous filling and emptying of the right and left hearts that may end in pulmonary congestion and edema.

The following case will illustrate this mechanism and the methods taken to combat it:

I. B., a female, age forty years, weight 144 pounds, height 5 feet 4 inches, had an adenoma of the thyroid. Thyroidectomy was performed under avertin, oxygen and ether anesthesia from 8.35 A.M. to 9.25 A.M., July 10, 1944.

On the table, the patient became cyanotic at the end of the operation but the condition cleared up with oxygen. On return to the ward, the color was poor but improved with nasal oxygen. The patient was conscious and talking for a few hours but then developed stertorous breathing and inspiratory dyspnea. Physical signs were moist râles throughout both lungs and pronounced cyanosis. The condition became aggravated and convulsions ensued. Tracheotomy was performed at 4.30 P.M., just as respiration ceased. After tracheotomy artificial respiration restored breathing and oxygen by catheter was passed through the tube but had to be removed frequently because of the great amount of edematous fluid coming through it. This fluid was removed by suction. Nasal catheters were employed for oxygen therapy and the tracheotomy tube was covered with a piece of wet gauze. Over these were placed the thyroid dressings. The wet gauze was placed there "to give moisture." The pulmonary edema continued throughout the night and cough and frequent suction removed the fluid from the tube. This necessitated taking the dressings off the tube frequently which probably is accountable for the patient's surviving the night. Cyanosis was intermittently present and dyspnea was severe. On examining this patient about twenty hours after the tracheotomy was performed, I found a robust, critically ill woman having difficulty in breathing (respiration 38, pulse 120, temperature 101.4°F.) and moderately cyanotic. On uncovering the tube there was expelled with each expiration a moderate amount of red-tinged fluid and an occasional cough brought up more. The respirations were noisy, the facies anxious and a fine moisture covered the skin. The nasal catheters were in place and running oxygen at the rate of 3 to 4 liters

per minute. A wisp of cotton at the mouth determined by its lack of motion that there was no respiratory exchange there above the tracheotomy tube and that oxygen therapy above the tube was useless. The wet gauze at the tube opening had had a ball-valve effect, more or less occluding the tube at inspiration thereby creating a greater negative intrapulmonary pressure.

It was evident that merely the removal of the ball valve obstruction to the tube would result in improvement which followed within a few minutes. The breathing was less difficult and the cyanotic color of the skin was less intense. However, the edematous fluid still was being expelled from the tube and the physical signs were those of pulmonary edema. The temperature, pulse and respiration were elevated and a stream of oxygen through the tube did nothing to better the condition because of the large amount of edema fluid that constantly came out of it requiring frequent suctioning to remove. It was then decided to institute oxygen under pressure through the tracheotomy tube in order to control the edema and to abolish the anoxia. This was done by means of connecting tubes as shown in Figures 1 and 2. The pressure was set at 6 cm. water on expiration and the oxygen concentration at 100 per cent at a flow of  $6\frac{1}{4}$  liters per minute. Within thirty minutes there was a decided improvement in the patient's condition (Fig. 3), the pulse rate dropped from 120 to 100, the respiration slowed from 38 to 26, and the physical signs of pulmonary edema had cleared to a large extent. The subjective change in the patient was most striking. Formerly, respiration was difficult and labored, restlessness was pronounced and the facial expression one of great anxiety. Now, she laid comfortably in bed, breathing was regular and easy and she expressed her gratitude in the absence of a voice box by kissing the operator's hand. Before the application of the positive pressure, it had been necessary to suction the edema fluid almost constantly. Under positive pressure suctioning was necessary only every hour for the first few hours and then the fluid became practically nil. The 100 per cent oxygen concentration was continuous and uninterrupted for forty-four hours without any signs of oxygen poisoning. The continuous and uninterrupted administration of 100 per cent oxygen for this length of time, without any

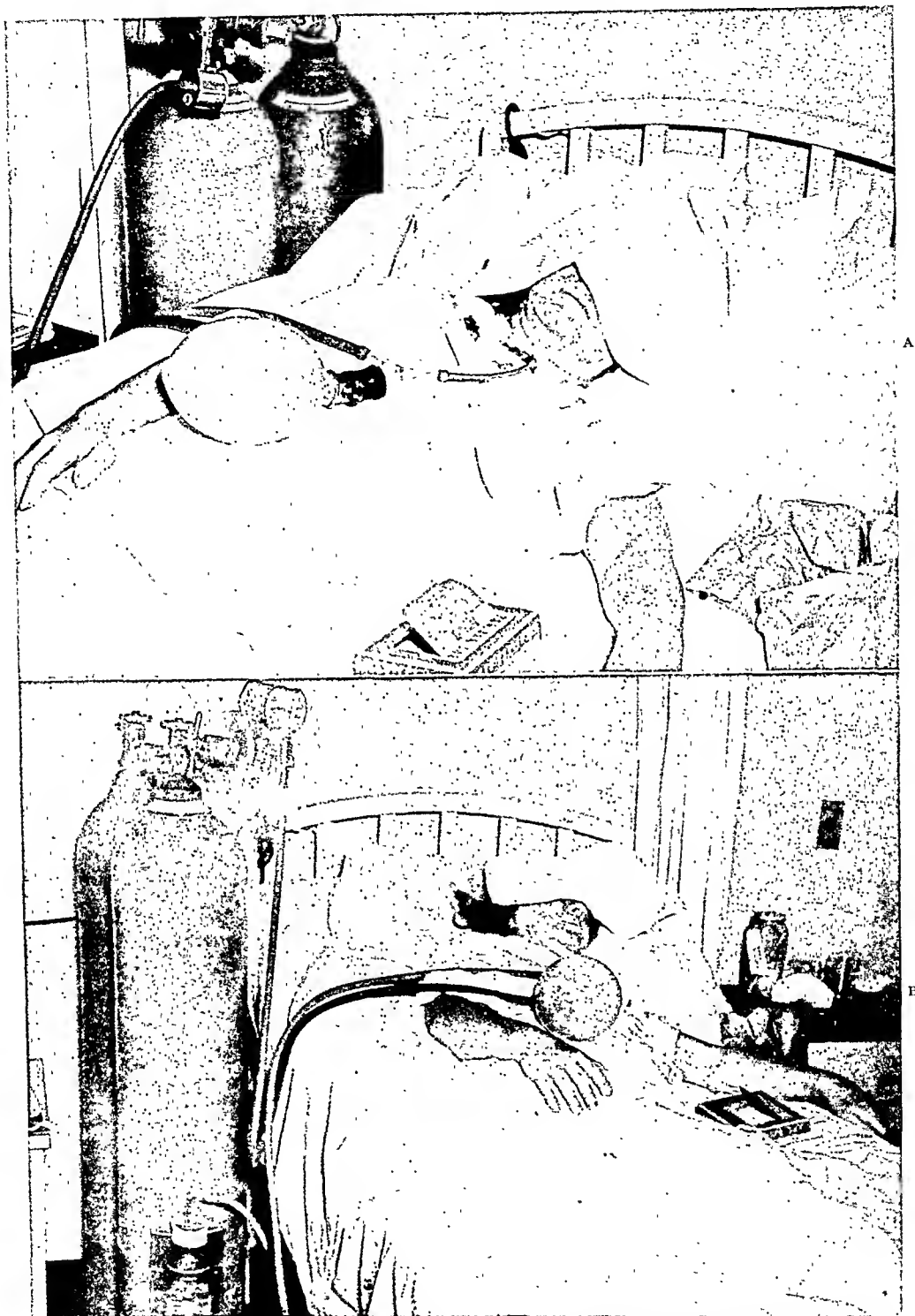


FIG. 2. A and B, apparatus in use connected to the tracheotomy tube in the patient. The rubber bag is a reservoir for the oxygen and not for rebreathing. Carbon-dioxide accumulation is not a factor as the expiratory phase of respiration carries excess carbon dioxide out through the water bottle.

evidence of oxygen poisoning, is noteworthy. Oxygen therapy by mask is marked by many interruptions, such as, eating, drinking, wash-

onset to combat this process and were effective. The temperature, pulse and respiration were slightly elevated on the sixth day postopera-

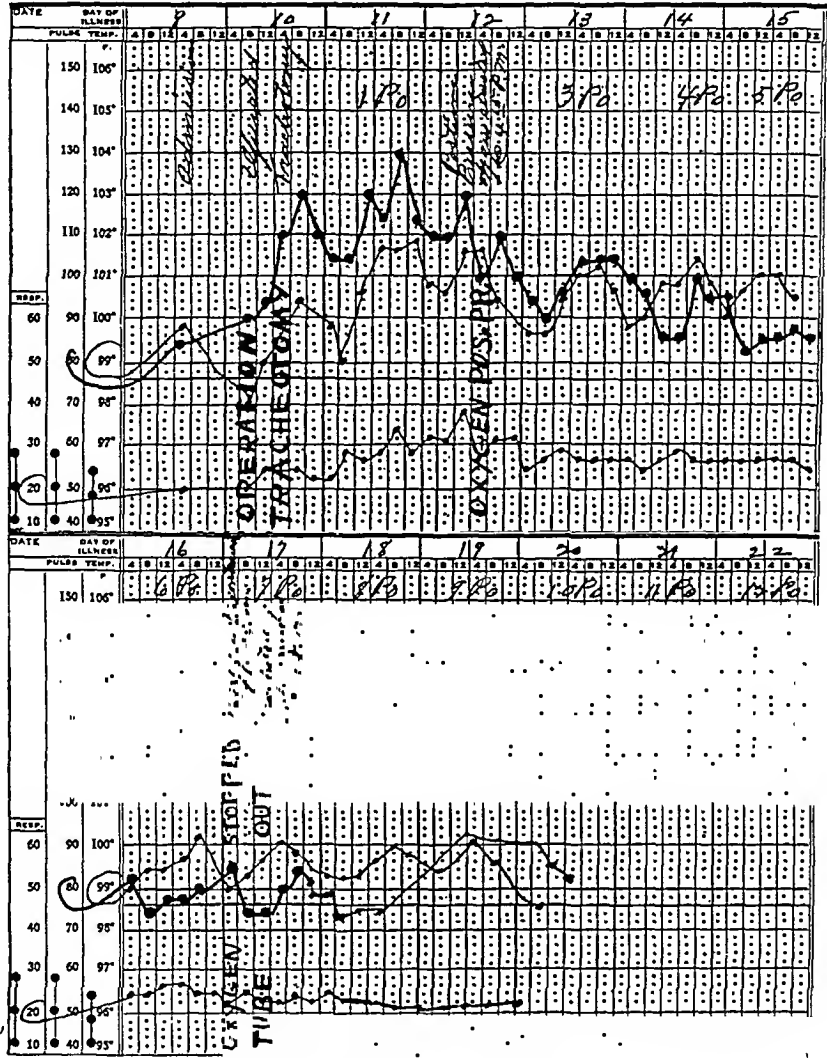


FIG. 3. Temperature, pulse and respiration chart of Case 11 showing the effect of positive pressure respiration.

ing the face and the patient's unwillingness to tolerate a mask more than a few hours at a time.

At the end of thirty-six hours of 100 per cent concentration there was some complaint of soreness in the chest (as noted in Behnke cases quoted by Barach<sup>10</sup>) but this cleared up in a few hours with the concentration the same. There was no nausea at any time.

A bedside x-ray taken on the third day after operation showed "consolidation in central portion of right lung." Penicillin by hypodermoclysis and intravenous drip and sulfonamides by mouth had been given from the

tively. The positive pressure was reduced gradually from 6 cm. water used for the first twenty-four hours to 3 cm. the next twenty-four hours and 1½ to 1 cm. for the next two days. After forty-four hours on 100 per cent oxygen, the percentage was reduced to 60 and then to 50 for two days more. Thenceforth, the apparatus was used intermittently—four hours on and one hour off (on the fifth day postoperatively) and two hours on and one hour off (on the sixth day).

The patient was allowed out of bed for a few minutes on the sixth day and the following day the oxygen was discontinued. On the

seventh day, the temperature was 99°F., respiration 24, pulse 86. The tracheotomy tube was removed on the same day and the patient thenceforth made an uneventful recovery.

#### COMMENTS

Barach<sup>10</sup> calls attention to "a direct suction action on the pulmonary capillaries by increased negative intrapulmonary pressure which results in transudation of serum into the alveolar cells as well as production of mucus from the intrathoracic bronchial mucous membrane. The heightened negative pressure during the inspiratory cycle also tends to draw blood into the right heart and at the same time hinders the passage of blood into the left heart and into the extrathoracic aorta. Experimental studies have demonstrated that prolonged pathologically elevated negative intrapleural pressures are followed by congestion and edema in the lung." This case well illustrates Barach's point of view and also demonstrates that respiratory obstruction need not be prolonged to result in pulmonary edema.

#### SUMMARY

Two cases of acute pulmonary edema are reported in which positive pressure respiration with oxygen was followed by a prompt clearing of the condition and recovery. The first patient was a physician who took an overdose of sedative medication the night and morning before operation. Respiratory depression following the operative procedure was considered the initial cause of the widespread pulmonary edema that ensued. Inhalation of oxygen by catheter, mask and tent failed to relieve either the cyanosis or the edema. The application of positive pressure by anesthesia mask resulted in a swift clearing of edema and cyanosis. This therapeutic procedure appeared to be the specific remedial agent since the signs of pulmonary edema recurred when the pressure was withdrawn and again disappeared when pressure was re-applied. The pulmonary edema in the second patient probably

resulted in the main from the primary tracheal obstruction (which necessitated the tracheotomy) and was aggravated by the ensuing ball-valve action of the wet gauze at the tube opening which resulted in an increased negative intrapulmonary pressure. This increased negative pressure produced an increased permeability of the pulmonary capillaries which resulted in a transudation of serum into the alveolar spaces as a result of a direct suction action on the capillaries. The removal of the ball-valve produced some improvement in the condition of the patient but she was literally "drowning in her own secretions" until positive pressure respiration dammed back the fluid. A simple apparatus was constructed which effected this promptly and efficiently.

Since the recovery of these patients could be attributed directly to positive pressure respiration, it is recommended that a more widespread use of this therapeutic procedure be adopted in combating what is so frequently regarded as a terminal clinical event. Although it is acknowledged that all cases may not react as favorably as these patients did, the prevention of an asphyxial form of death may in many instances make possible opportunities for recovery that would otherwise not be present.

The author is indebted to Mr. George R. Fairlamb of the Scully-Walton Company for valuable technical assistance.

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THAT blast injury to the lungs is present should be suspected when there are diminished movements of the diaphragm, fullness of the chest, giving it an emphysematous appearance, and impairment of resonance at one or both bases. It is usual to find the lower chest ballooned, especially in the region of the lower costal margin.

From "Surgery of Modern Warfare" edited by Hamilton Bailey (The Williams and Wilkins Company).

# SKIN GRAFTING BY THE GENERAL SURGEON

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THERE is no good reason why the general surgeon should not do a free skin graft when indicated,—and the indications are far more frequent than is usually recognized. There is every good reason why he should do so. An exact technic, meticulously followed, makes it possible for the surgeon previously inexperienced in this field to achieve as good results as the experienced plastic surgeon, and to do so in less time than has heretofore been considered necessary.

These statements are made thoughtfully as the result of experience gained in twenty years of plastic surgery and culminating in intensive work with the United States Army in the South Pacific. The facts on which they are based are presented in this paper, together with the details of the technic.

Skin grafting has too long been left to the hands of the relatively few plastic surgeons, who receive for repair the victims of embryonic mischance, industrial or traffic accident, chronic ulcerations, burns and surgical necessity or misadventure. All too often so much time has elapsed or so many attempts have been made to substitute ordinary surgical procedures for proper skin grafting that it is impossible for the specialist to restore normal function and appearance. The results are unfortunate from the Hippocratic and from the social viewpoint, for they entail both human misery and economic waste.

The chronics with seemingly hopeless deep ulcerations; with contractures of the extremities, with surgical and traumatic wounds that stubbornly resist the ordinary aids to healing have been problems of the physician in his daily ward walks, his clinics, and his practice. Such patients have been unwelcome because of our

previous inability to bring about permanent closure even by unsightly scarification, and have frequently become pathetic migrants from office to office, from clinic to clinic.

Patients with crater type varicose ulcers have been hospitalized for palliative immobilization, local medication and elastic bandaging. X-ray burns have been treated with emollients, anodynes and local anesthetics; amputations of finger-tips, of fingers, and then of hands have been common sequelae of such treatment. Surgical wounds that failed to heal by primary or secondary intention have remained as contaminated wounds for long periods of time, especially those primary or secondary closures which because of undue suture tension slough and become infected. Radical mastectomy has frequently been followed by a stubborn open wound or by marked contracture limiting the mobility of the pectoral region, shoulder and arm; and contractures following scarring of the extensor and flexor surfaces of the extremities have been a common cause of vocational handicap and industrial loss. Scar contractures in the region of the face and neck are a frequent cause of psychological difficulties.

An important practice in present military surgery can be used to advantage in civil life, namely, the care of large surface wounds and severe burns with a view toward coverage with skin grafts just as quickly as the wound permits. Treatment begins from the moment the soldier is hit or burned. A free graft is applied as soon as the area is ready to receive it. The hospitalization period is reduced to a minimum, contracture is prevented, and the need for later plastic surgery is frequently obviated.



In civil practice it has been customary to permit such cases to go into convalescence for many months. Such waste is entirely unnecessary. Burns, automobile accidents, industrial accidents and surgical defects should be a constant challenge to the alert surgeon. It is his responsibility to recognize wounds which require skin graft coverage, particularly in flexor-extensor areas, and to prevent disfigurement and vocational loss by adequate early treatment.

In the South Pacific war zone, the most frequent needs for skin coverage have been in the amputations of extremities, fragmentation wounds of the body, and new and old explosive burns. The soldiers under the author's care were in surgical wards that were rife with hemolytic streptococci, *Bacillus pyocyaneus* and gas bacilli. It was necessary to simplify all procedures to the greatest possible degree, and both from choice and from necessity numerous departures were made from established preoperative, surgical, and postoperative technics. Yet under the routine which was worked out the results were uniformly and astonishingly successful. The procedure has since been followed in private practice with equally good results for all cases, regardless of the type and age of the defect. It is the contention of the present discussion that the 100 per cent take can be the rule and not the exception.

The technic involves: (1) Proper choice of graft; (2) a specific routine to prepare the wound for coverage; (3) a specific surgical technic for preparation and application of the graft, and (4) a specific postoperative treatment.

To demonstrate that strict application of the definite rules of the technic, rather than specialized experience, is the secret of successful skin grafting, a practical experiment was carried out.

In a case of angioma of the nose, a full thickness graft was necessary to repair the excision. A resident surgeon who had not previously performed any similar operation was given the details of the technic

which will be presented in this discussion. He performed the operation, under supervision but without any additional assistance.

On the assumption that because the operation had been carried out by inexperienced hands the take might be unsuccessful, the original dressings were removed earlier than is advisable, on the fourth postoperative day, and the graft was inspected. Its appearance was entirely satisfactory. A second pressure dressing was applied. The patient left the hospital following this change of dressings and was ambulant during the remainder of the postoperative period. At no time was there any complication. The end results were all that could be desired.

It was thus demonstrated that strict application of technical principles rather than specialized experience is the crucial factor in successful skin grafting.

#### THE TECHNIC

*Choice of Graft.* In over 90 per cent of all cases a free skin graft will be the graft of choice. The usual thicknesses for such grafts are (1) the Thiersch—one-fourth to one-fifth of full skin thickness; (2) the split—one-third skin thickness; (3) the three-quarters, and (4) the full thickness graft. In all cases a permanent skin graft should be taken from the patient himself, never from another person. It is a curious paradox that a man may accept another's blood but not his skin.

The thickness of the graft depends upon the nature of the wound it is to cover. The condition of the wound, whether a fresh granulating surface, an infected wound, or a chronic lesion, is one determinant. Its location, whether on a flexor-extensor surface where the greatest possible function must be preserved, in an exposed area where disfigurement must be avoided, or in a relatively immobile area, is another factor.

Surfaces requiring grafts may be divided into three categories: The first class includes the new aseptic surgical wounds,

such as those following the excision of large contracted scars, the removal of large growths or nevi in soft structures, including the skin, and such operations as radical mastectomy. The second class includes the contaminated wounds of recent origin, such as third degree burns from fire, chemicals and other sources, and injuries from industrial, automobile or other accidents. The third class includes the chronic lesions, the crater type varicose ulcers, x-ray and radium burns, and non-healing surface wounds where surfaces cannot be approximated without distortion, loss of function or recurrent breakdown of the attempted repair.

The first class, the new aseptic surgical wounds, may receive either split, three-quarters or full thickness grafts. On surfaces that are not subject to contraction, the split thickness is ideal; on areas involving flexor-extensor surfaces of the body a thick free graft is used. The second class, the recent contaminated wounds, should receive Thiersch or split grafts. The third class, the chronic lesions, may be covered with either split or full thickness grafts, the choice again being dependent on the location.

*Preoperative Care.* Preoperative care is determined by the nature of the wound.

*Acute Aseptic Surgical Wounds.* Being acute and aseptic, these patients do not require preoperative care. Emphasis cannot be too strongly placed, however, on the importance of placing a skin graft over a surgical defect at the time it is created. When approximation of the edges of a wound is not possible without undue tension, because of destruction of surface or of underlying structures, skin grafting should be carried out at once, at the time of operation, to avoid resultant disability or the ultimate necessity for secondary surgery to effect closure. In borderline cases the possibilities of producing disfunction or disfigurement by so-called "conservative" methods are far greater than the possibility that a graft might have been unnecessary.

*Acute Contaminated Wounds.* Approximately four weeks of preoperative preparation are required before skin grafting is done. Careful débridement of the affected area is the first step. It must be carried out in the operating room with complete surgical technic, that is, the patient should be draped and all procedures carried out as for any radical surgical operation. Soap and sterile water and saline solution are used as needed. After débridement, the wound is dried and sprinkled liberally with sulfanilamide powder. Pressure dressings are then applied. Gauze pads saturated with isotonic saline, magnesium sulfate or saturated boric acid solution are first placed over the wound. The boric acid solution should be used only for wounds in which the denuded area is so small that there is not sufficient raw surface for toxic absorption. The wet pads are covered with a heavy padding of lint thread waste material and the entire dressing is now encased with thick roller bandage.

In all cases this initial dressing is allowed to remain for a week to ten days. Where large areas are involved the dressing is allowed to dry out after the initial soaking in order to avoid serum loss. In less extensive areas, where serum loss is not a serious problem, the dressings are saturated three times daily with the boric acid solution.

During the preoperative period every systemic support is given in order to make the patient an optimal surgical risk. A high protein diet is indicated. The red count and hemoglobin are followed. If the red count is 3.5 million or lower a preoperative transfusion of 500 cc. of whole blood is given. It may be necessary to repeat this in seventy-two hours, particularly in operations involving facial areas.

After the initial period of a week to ten days following débridement, the original dressing is removed and the wound is inspected. A prolonged soaking in isotonic saline will be necessary to prepare for removal the dried dressings over large wounds. From this point on, the wounds are dressed daily for an additional two to

three weeks with the same type of dressing and solutions as before; both large and small wounds are now kept saturated with the appropriate solution, since danger of serum loss is now past. By the procedure the bacterial flora present in the area are carried away. The objective is to obtain a bacterial count in the injury which is no higher than that of normal skin, and the daily dressings are carried out until the granulation surface is free of necrotic material and appears cherry red. With such a surface, and following such technic, the surgeon may feel assured that the count is sufficiently low to justify coverage. For one week prior to surgery the wound is sprinkled daily with sulfanilamide powder before the wet dressings are applied.

Rarely, the surgeon may encounter infection with *Bacillus pyocyaneus*, which may be recognized by the characteristic odor and greenish discoloration of the dressings. The use of a 2 per cent solution of acetic acid on the dressings for a period of four or five days is effective in these cases.

*Chronic Lesions.* The procedure is similar to that for the recent contaminated wounds, careful débridement and the use of wet pressure dressings. The preoperative period is usually from ten days to two weeks. Since these areas are usually small, boric acid dressings are used. They are changed daily from the beginning, and are saturated three times a day with boric acid solution. The patients are ambulant during this period unless the lower extremity is involved. In the latter case the patient is put at bed rest, with the limb elevated, for the entire period. If the upper extremity is affected, it is immobilized in a sling. For three days prior to operation, the wound is dusted with sulfanilamide powder at the time the wet dressings are changed.

If the preoperative procedures given above are meticulously followed, half the take is already achieved. Underlying infection and inexact surgical technic share the responsibility for failure in skin grafting.

## SURGERY

*Site of Graft.* The first choice for the donor site, if the lower extremities are not involved in the injury, is the inner or outer aspect of the thigh, the first preference being the right thigh. The second choice is the abdomen, and the third, the buttocks. If a dermatome is used to take the slice of free skin the graft may be obtained from thigh, abdomen, chest, back or buttocks, and it is possible to obtain large sheets with this instrument. For the average wound—20 by 35 cm. or less—a long-handled blade or razor can be used to obtain skin sections of similar size. Small aseptic wounds in the face can be repaired with full thickness grafts from the postauricular area or from beneath the chin line in the neck. If the wound is of moderate size, full thickness grafts can be removed from the abdomen. For correction of ectropion of the lid, the defect resulting from release of the ectropion may be repaired with a full thickness graft taken from the upper lid.

The donor site for any graft up to full thickness will regenerate a new surface corium and epidermis within two weeks. When a full thickness graft is taken, a Thiersch or split graft will be necessary to repair the donor site if the area is large.

*Instruments.* The cutting instrument used in taking the graft can be the scalpel, razor, long-handled blade or dermatome. The type is not important. While it is true that the Padgett-Hood dermatome<sup>1</sup> is convenient, accurate, and greatly facilitates taking the graft, success in the operation is dependent not upon any gadget which determines thickness to the thousandth of an inch but upon the knowledge of the indications for the use of various thicknesses of free skin, and upon the preoperative and postoperative management of the patient. A Blair suction box is a valuable adjunct if a dermatome is not used, and is not expensive.<sup>2</sup>

The surgeon who uses a razor or long-handled blade to obtain his free graft will be able to obtain grafts of approximately

Thiersch or split thickness, and, obviously, of full thickness. In practical use these gradations are sufficient. Slight variations in thickness will not interfere with the success of the take if reasonable care is exercised. The three-quarters graft must be taken with a calibrated instrument such as the dermatome.

*Taking the Graft.* The donor site is cleansed with soap and water, followed by alcohol and ether. Chemical antiseptics are not used, as they may interfere with the vitality of the skin.

A Thiersch graft, the thickness of tissue paper, is best taken with a long-handled blade or a sharp razor. The site is covered with a thin film of vaseline. The assistant makes traction upon the skin in order to present a taut surface to the surgeon's blade. A sawing motion, with short rapid strokes, is used to obtain the thin shaving of skin. It is advisable to remove one continuous strip of skin even if it should prove to be larger than the defect, rather than two or more small sections.

A split graft is taken in the same way as a Thiersch, except that the skin is nicked so that an intradermal slice one-third of skin thickness—approximately the thickness of this journal page—is obtained. As in the Thiersch graft, one continuous sheet is preferable to two or more sections.

In taking a split or Thiersch graft the use of a Blair suction box to obtain exact traction is highly desirable. Although two are recommended, one box, held in the operator's left hand and advanced just ahead of the blade, is sufficient to obtain an even graft. If the purchase of two boxes is considered, it is preferable to have them of different widths.

A three-quarters graft can be taken only with a Padgett dermatome. The advantage of this thickness is that sufficient epithelial elements are left at the donor site to permit spontaneous regeneration of the skin, yet the graft may be employed wherever a full thickness graft is indicated.

A full thickness graft is obtained with a sharp scalpel. It must be completely devoid

of subcutaneous fat and must be cut to an exact pattern the size of the defect.<sup>3</sup>

*Preparation of Wound and Placing of Graft. I. Acute Aseptic Surgical Wounds.* Persistent bleeders are tied off with very fine silk or cotton.<sup>4</sup> Warm saline pressure packs are then pressed firmly over the wound to control oozing. The desired graft, split, three-quarters, or full, is now taken. For the full thickness, an exact pattern of the defect is cut from gauze, tinfoil or lead, and the graft is cut from this pattern. It should be noted that such grafts contract from 20 to 30 per cent when taken, but proper application restores the graft to its original size and tension.

If the wound is still oozing when the graft is ready, the packs should be replaced and the graft folded upon itself, raw surface to raw surface, and placed between layers of moist gauze. If the graft is on a dermatome drum the raw surface is similarly covered with a piece of moist gauze. The graft must not be kept in normal saline solution; such a procedure tends to wash out the serum from the intercellular spaces, and this serum is essential for proper fixation of the graft to its bed.

Once oozing has ceased, and the wound bed is dry, sulfanilamide powder is sprinkled over the surface. The graft is now laid over the wound. Two Allis forceps, about an inch apart, are used to hold a section of one edge of the graft. The section is approximated to the border of the wound under strong tension while the assistant takes the first stitch. The remaining sutures are placed  $\frac{1}{4}$  inch apart, an Allis forceps being placed in advance, to maintain the strong tension, as each stitch is taken. All excess free skin is excised and the borders of graft and wound are exactly coaptated. A properly sutured graft is smooth, tense and flat upon its bed.

After the graft is in place several piecrust cuts are made to provide an escape for blood and serum. The pressure dressing is then applied.

Wide mesh gauze that has been moistened with normal saline solution is first

applied. Several thicknesses of moistened gauze pads are then placed on and around the grafted area. Marine sponges that have been soaking in a bowl of normal saline solution are now expressed and placed over the pads. For large coverage, e.g., an entire extremity, a liberal padding of lint thread waste material is used instead of the sponges. A wide heavy roller bandage incorporates sponges or padding; it is applied with moderate firmness for an equal steady pressure. The final covering is with a three or four inch roller bandage.

If the area is on an extremity, a wooden splint, well padded, is incorporated in the original dressing, and the toes or fingers are taped to the edge of the splint to prevent movement. In all cases the pressure from the dressing should extend well beyond the site of the graft.

*II. Acute Contaminated Wounds.* The granulation surface of these wounds receives a Thiersch or split graft, never a three-quarters or full thickness. The latter will give at best only a small percentage of take, while with the Thiersch or split the take should be 90 to 100 per cent.

During preoperative preparation a variable amount of young scar tissue will have formed about the border of the wound, making the original defect smaller as a result of contraction. This area must be excised. An incision is made in the healthy skin about one-quarter inch beyond the scar area, and scar and skin are removed. The borders are now freely undermined to release completely any constriction, thus restoring the wound to its actual dimensions and the bordering skin to its normal tension. The area of new granulation is left undisturbed.

The rest of the operation is carried out as previously described. Bleeding and oozing are controlled, the graft is taken and sutured in place under tension, and pressure dressings are applied.

*III. Chronic Wounds.* The purpose of the preoperative preparation of these cases is to reduce to a minimum the degree of

contamination or infection. It does not obviate the necessity for radical débridement.

An incision is made in the healthy skin at least one-half inch beyond the borders of the old wound. The knife penetrates all skin layers down to the fascia, undercutting the unhealthy tissue so that at all times the blade is in the uncontaminated underlying tissue. Bleeding and oozing are then controlled and the graft applied as previously described.

If the area is large and the danger of postoperative contracture minimal, a split graft is used. Usually, however, these wounds are of moderate size and a three-quarters or full thickness graft is indicated. The pattern for the full thickness graft is made after the débridement has established the final outline of the wound. The usual pressure dressings are applied.

*Treatment of Donor Site.* Pressure dressings are applied to the donor site just as to the wound itself, except that additional adhesive strips are added for fixation. If a large full thickness graft has been taken, it will be necessary to apply a secondary Thiersch or split graft as to any aseptic wound.

#### POSTOPERATIVE CARE

The total postoperative period is three weeks. The two most important factors in treatment are immobilization of the area and maintenance of moisture in the dressings during the first part of this period.

*Immobilization* must be complete for five to seven days. It is essential because any movement entails the danger of rupture of the new capillaries which are establishing circulation between graft and bed, thus insuring the take.

Every precaution should be taken to insure complete immobilization. The incorporation of splints in the pressure dressings of wounds of the extremities has been mentioned. The extremity rests on a pillow (covered with rubber sheeting) and the splint is tied to the side or foot of the bed as required. In wounds of the chest or

abdomen the torso should be completely, not partially, encircled with adhesive bandage, and the patient kept in a semi-recumbent position.

A few opiate suppositories given post-operatively will facilitate immobilization by lessening the desire for evacuation during the seventy-two hours following surgery. This is especially desirable if the hip or lower extremity is covered with a graft.

*Moisture* is essential to insure continual drainage and thus keep the bacterial count minimal. Rubber sheeting is used to cover the bed and cellophane or rubber is applied over the pressure dressing in order to retain moisture. During the first ten days the dressings are soaked in boric acid solution three times a day.

*Inspection* of the graft is carried out on the fifth postoperative day for split and Thiersch grafts, and on the sixth postoperative day for three-quarters and full thickness grafts. A temperature elevation without accompanying necrotic odor is not sufficient reason for earlier removal of the original dressings. However, a necrotic odor, with or without temperature elevation, justifies inspection of even a full thickness graft as early as the fourth day. Such an odor indicates that there has been some failure in technic. By prompt inspection and removal of any areas of beginning necrosis, careful re-dressing, and immobilization a greater part of the graft may be saved. If early inspection is not carried out, the necrosis resulting from uneven pressure, slipping of the dressings or faulty immobilization may give only a 20 to 30 per cent take. In modern skin grafting this percentage represents failure.

After the first inspection the grafted wound is redressed with several layers of gauze moistened with boric acid solution. Over this is placed a heavy dressing of lint thread waste material, which is in turn pressed firmly with gauze and an elastic roller bandage. The dressings are now changed every two days. As previously mentioned, the soakings are continued for ten days in all. They are carried out after

the application of the elastic bandage by means of a syringe inserted under the upper margin of the dressing. Relative immobilization is now sufficient and the patient may be ambulant. Sutures are removed two days after the original inspection. This period of relative immobilization with moist dressings should last for one week.

The donor site for a graft of less than full thickness should not be disturbed until a new epidermis has been regenerated, usually in ten to fourteen days.

A final week—the third postoperative week—is marked by the change to dry dressings with an elastic bandage to give firm support. The patient may then be discharged.

#### COMMENTS

This paper is addressed to the general surgeon, not to the specialist in plastic surgery. Every step in technic, from choice of graft to postoperative dressings, has been described from this point of view.

It is our contention that there will always be more than enough specialized work for the plastic surgeon, and that there is no need either to dispense with, or to call on the specialist for, the basic type of graft which should be a part of the general surgeon's armamentarium. There will be some cases which are beyond the province of the general surgeon; he will obviously not wish to handle complicated facial repairs. There will be certain other cases which will require additional work after successful initial grafts; for example, very large burns which have been properly covered with Thiersch grafts may in some instances require later plastic surgery. By the early use of grafting the patient is spared the risk of infection and a long period of hospitalization, and the task of final restoration is infinitely lightened and may be carried out at a convenient time. The specialist will always salute, rather than criticize, any general surgeon who sends him a case in which such coverage was done and rehabilitation effected, even



A



B



C



D

FIG. 1. For remainder of Fig. 1 and legend see opposite page.

though complete one-step restoration was not possible.

In spite of the quantity of discussion of

previously stated that for over 90 per cent of cases in which skin grafts are required the free graft is the proper choice. The



E

FIG. 1. These illustrations show a case of a type frequently seen, and demonstrate proper and improper use of skin grafting. Overdosage of x-ray in the treatment of eczema resulted in keratotic patches and ulcerations on the dorsum of each hand. In 1942, the left hand was repaired with a three-quarters graft. A similar procedure was planned for the right hand, but before it could be done the author was called to service in the United States Army. Another surgeon attempted the repair by the use of a skin flap from the abdomen, a type of covering which opposed the physiology and anatomy of the affected structure. The flap was removed and replaced on the author's return to civil practice, but irreparable damage had already been done. A, taken in 1943, shows the excellent condition of the properly covered left hand and the disfigurement and distortion of the right hand. Note in the latter the venous and lymphatic incapacity and the awkwardness and bulkiness of the flap. B, shows the condition of the right hand in 1944. Note the hairiness of the graft, the ankylosis of the index finger, and the limited extension and flexion of the remaining fingers. The remaining pictures show the final repair of the right hand after removal of the skin flap. C, the wound bed immediately after removal of the flap, before the placing of the graft; D, the graft after removal of the first dressing, six days postoperatively, with the sutures intact; E, the graft three weeks postoperatively, at the time of discharge of the patient.

skin grafting in the literature, there is relatively little detailed material on the technic, and much of that available is outmoded, nebulous, or contradictory. Certain differences between the methods presented here and those frequently practiced will therefore be explained; important details will be re-emphasized; and explicitly or implicitly opposing views in the literature will be discussed.

Skin flaps and pinch grafts, concerning which there is much available material, were not described in this paper. It was

skin flap is frequently needed and is outside the province of the general surgeon; the pinch graft is an unsatisfactory emergency measure, to be used only under force of necessity.

The skin flap is used chiefly for contour defects, for padding, or for greater protection in weight-bearing areas. Thus it is used for partial or total reconstruction of missing facial features (nose, ear, chin, cheek); for deep sub-fascial defects where padding is required to approximate normal levels; for repair of the heel or of the palmar



surface of the hand. Such work requires much time and study, specialized anatomical knowledge, and the technic for transplants of bone, cartilage and other tissue fillers. It is not in the field of general surgery. (Fig. 1.)

The pinch graft is a makeshift, and its use should be avoided if it is at all possible. In a patient with a very extensive burn, of such degree that there is not available a sufficient amount of healthy skin from which to take large free grafts, the use of multiple pinch grafts may be advisable in order to obtain at least partial coverage of any flexor or extensor surfaces involved. The use of the pinch graft does not materially reduce the period of convalescence; it is objectionable from the aesthetic point of view if the face, neck or dorsum of the hand requires coverage; and it is subject to contamination and infection at both receptor and donor sites during the recovery period.

The proper choice of graft is simple if the tabulation given in this paper is followed; failures from this source should be obviated from the beginning.

*Preoperative Care.* It should be emphasized that all except the acute aseptic surgical wounds are contaminated, and that the object of the preoperative care is to reduce to a minimum the bacterial flora present. The acute aseptic wound should be covered at once, at the time of operation.

Sulfanilamide powder, not a crystalline sulfonamide, is used for dusting the area of the wound, whether preoperatively or at the time of surgery.

*Surgery.* It was noted that if there is any lapse of time between the taking and the placing of the graft, it should be kept moist; but we reiterate that it must not be "drowned" in saline solution. The latter is a common error in technic.

Some authors have recommended "moderate" tension on the graft while it is being sutured into place. The tension should be strong rather than moderate; and exact coaptation must be made. The graft must never be allowed to overlap; for such over-

lapping areas will necrose, the surgeon will note the odor and assume that the necrosis is due to a failure in the graft itself, and the initial dressings will consequently be removed too soon.

In acute contaminated wounds, it is most important that free undermining of the border of the wound be carried out as directed. Proper tension and coaptation, and hence a perfect take, are not possible if this procedure is not thoroughly carried out. Similarly, in the chronic wounds it is essential that the débriding knife be at all times well beyond the limits of the unhealthy tissue, in an aseptic area.

The use of a greasy substance (vaseline, xeroform, sulfanilamide cream) over the graft has been advocated. This practice is contraindicated for several reasons. In the first place, there is danger that a greasy or waxy substance may penetrate and lodge beneath the graft, thus preventing a take by its mechanical interposition between graft and bed, or causing the formation of a paraffinoma. Secondly, the odor of such a substance may be mistaken for that of necrosis postoperatively, and the dressings may thus be removed for inspection earlier than is necessary and advisable. Thirdly, immobilization is endangered. The bandages have a tendency to slip, and if this occurs the resulting uneven pressure may result in a partial loss of the graft.

It has also been common practice to dress the donor site with gauze impregnated with grease, the area then being firmly encased in roller bandage. Within forty-eight hours such a dressing tends to slip and become painful.

Extension of the pressure dressing well beyond the actual area of the graft was emphasized. This is necessary not only to insure immobilization but also to assure proper circulatory control.

*Postoperative Care.* Wet dressings are used for all types of graft to make certain that drainage is adequate. The basic assumption is that the graft is contaminated, regardless of its condition or the care which has been exercised to make or

to keep it aseptic. This assumption is the surgeon's insurance against any possible slip-up, and his assurance of a complete take. He cannot, in any case, afford the risk of modifying the routine, no matter how "clean" the case may seem.

Inspection of Thiersch and split-grafts on the fifth, and of three-quarters and full thickness grafts on the sixth, postoperative day has been recommended as a routine; if a necrotic odor is noted, inspection should be done and débridement carried out as early as the fourth day, regardless of the type of graft. These recommendations are at variance with those usually given; it is frequently said that inspection should not be done for ten to fourteen days. Such delay is not only unnecessary but also dangerous. Tiny areas of necrosis, which might easily have been removed earlier, will spread; blisters and scabs will form; and partial or complete failure of take may ensue. In much of the earlier literature, it is apparent that a 50 per cent take was once considered a success; at the present time it should certainly be considered a failure and a confession of improper care. By the simple use of his olfactory sense, and by early inspection when it signals the need, the surgeon will avoid many such failures.

*Skin Graft versus Secondary Closure.* While late repair is obviously better than none at all, it is discouraging to realize that many excellent and accomplished surgeons have failed to recognize the full possibilities of early skin grafting. The graft has been thought of as a last resort, whereas it should be the first consideration for any large wound which cannot be closed without undue constriction or tension and the consequent dangers of either failure of closure or interference with circulation, nerve supply and muscular movement.

A recent article by Crile<sup>5</sup> may be discussed as an example of the negative point of view so diametrically opposed to ours. We quote his summary: "The effective secondary closure of wounds shortens the

duration of convalescence and minimizes deformity from contracture. Whenever possible, closure of a defect by suture is preferable to the grafting of skin." Earlier, he states "It is a good rule, therefore, to close an old wound promptly and to delay in closing a small wound of recent origin." Secondary closure is preferred because "A skin graft . . . must be protected from trauma for weeks or even months, and, in areas subjected to weight-bearing or trauma may never afford a satisfactory surface."

Let us consider the case shown in Figure 2. Here two attempts were made to close a surgical wound of the leg by ordinary means. The attempt to achieve primary closure under undue tension resulted in a slough. Secondary closure, with free undermining, tension sutures and immobilization, was also followed by considerable separation and sloughing. The case was referred for skin grafting. The usual three weeks of preoperative care were then required before the wound could be repaired with a free graft. Thus three months of hospitalization were needed for a patient who could have been ambulant within a week to ten days following the original operation.

In spite of every attempt to close such wounds, in spite of the adoption of two steps from the skin grafting routine, pressure dressings and immobilization, again and again these methods fail. Results may be particularly tragic in wounds of the extremities. A large wound elsewhere may be brought together by traction and undercutting, and some sort of closure, however unsatisfactory, may be effected without too great loss of function. In an extremity, however, the resultant massive cicatrices may, in themselves or as a result of an associated edema or phlebitis, cause an absolute loss of function. By the time the case is referred for skin grafting, this loss is all too often permanent.

In regard to the qualities of the graft itself, a split, three-quarters or full thickness graft is as resistant to trauma and to

the outdoor elements as its surrounding skin, and is no more susceptible to erosions or breakdown. A Thiersch graft is liable

Initial coverage with a Thiersch graft converts an acute open surface wound into a closed one. The treatment helps the

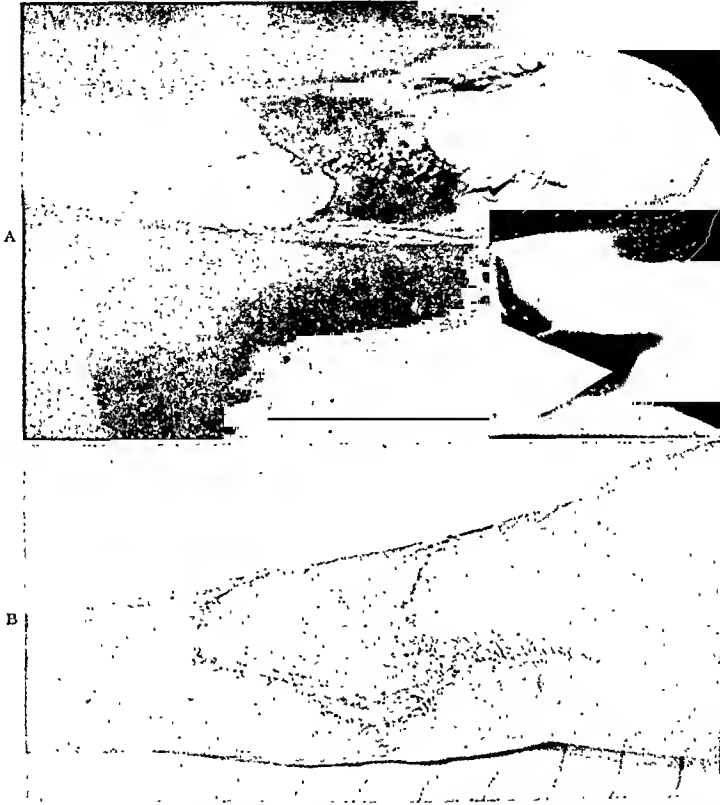


FIG. 2. These photographs show a surgical defect resulting from an attempt to close a surgical wound under undue tension, before and after repair. A, the wound before grafting, three months after its inception; B, the graft at the time of first inspection, five days postoperatively. Coaptation is exact and there is no sign of any stitch abscess or of contamination along the line of suture. Note the rough appearance of the graft; this is due to cornified surface epithelium, normally present at this time, which will be cast off in a few days. (In Fig. 1, D shows partial and E shows complete casting off of this surface layer.)

to breakdown with extreme muscular effort and bruising. This type of graft is used only to cover large granulation surfaces, the result of acute burns or acute accidental wounds. A thick graft will not take on a granulation bed. When a Thiersch graft is used it may be necessary, six to twelve months postoperatively, to excise a part of the graft and in its place use a three-quarters or full thickness graft. This is true particularly for flexor-extensor areas, where postoperative contraction or inadequate protection must be taken into account.

patient to recuperate quickly, avoids infection, and minimizes hospitalization. Where true plastic surgery is ultimately required, and no specialist is available locally, immediate coverage makes it possible to refer an ambulant, partially rehabilitated patient to a medical center.

It is thus difficult for the plastic surgeon, who daily sees case after case in which early skin grafts would have saved months of suffering, expense, and industrial loss, to understand the negative attitude which Crile's article exemplifies. Such understanding becomes impossible when one has

seen the possibilities of the positive attitude in dealing with the casualties of war. It is hoped that this positive attitude will be developed by the general surgeon toward the casualties of civil life.

#### SUMMARY

The free skin graft should be part of the regular armamentarium of every gen-

eral surgeon. The widespread possibilities for its use have been pointed out, and the technic for its successful employment has been given in detail.

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CERTAIN living tissues will grow in a medium consisting of Tyrode's solution, buffered salt solution, heparinized plasma and embryonic extract. Neither the plasma nor the embryonic extract need come from the same species of animal.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# A NEW TECHNIC FOR RECONSTRUCTION OF THE OVIDUCTS

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THE following technic for reconstruction of the oviducts was found to be successful in two cases of infertility due to bilateral occlusion of the oviducts at the cornua. My criteria for success are the establishment of tubal patency followed by pregnancy. I used certain features of the technics described by Curtis,<sup>1</sup> Solomons,<sup>2</sup> Holden and Sovak,<sup>3</sup> and Sovak.<sup>4</sup> To these I added the new features described in steps 5 and 6 below:

## TECHNIC OF OPERATION

*Step 1.* Retrograde insufflation of the oviducts demonstrates the sites of occlusion. (Fig. 1A.)

*Step 2.* The endometrial cavity is exposed by a longitudinal incision about 2.5 cm. long on the anterior surface of the fundus. (Fig. 1B.)

*Step 3.* The occluded portions of the oviducts are resected. (Fig. 1C.) After my experience with the first case, in which I resected both oviducts, I now resect the duct on one side only. I believe that when both ducts are reconstructed there is too much encroachment upon the endometrial cavity, thus preventing a proper nidus for the impregnated ovum. However, each operator must decide this for himself.

*Step 4.* The oviduct channels in the cornua are widened by means of a reamer. (Fig. 1D.)

*Step 5.* A small curved hemostat is directed into the anterior fundal incision through the widened oviduct channel in the cornua. Then, with the blades of the hemostat, gently grasp the resected oviduct at one portion of its periphery. (Fig. 2.) Upon withdrawing the hemostat, the oviduct is brought snugly into place within

the endometrial cavity. A few fine catgut or silk sutures are used to anchor the tube outside to the cornual surface of the uterus and to close the defect in the broad ligament. No sutures are used inside the uterus. (Fig. 3.)

*Step 6.* Retrograde instillation of sterile normal saline solution proves the patency of the reconstructed oviducts by direct vision through the anterior fundal incision. (Fig. 3.) I now follow this with Solomons' technic of weaving a strand of plain No. 0 or No. 1 catgut through the patent tube and place a figure-of-eight knot at each end, one just outside the fimbriated end of the duct and one inside the uterine cavity.

*Step 7.* After patency is demonstrated (and maintained by the strand of catgut) the fundal incision is closed with two layers of catgut sutures in the myometrium and one layer of catgut or silk on the peritoneal surface. (Fig. 4.)

## CASE REPORTS

**CASE 1.** (History No. 55721): In 1936, M. J., aged twenty-one, married two and one-half years, presented herself for examination with a chief complaint of infertility. Her husband had one child, aged ten, by a previous marriage. The patient had had an abortion performed during her first year of marriage. Contraception was practiced for one year following the abortion. Then, for more than a year, no precautions were taken and no pregnancy followed.

On November 21, 1936, I performed a utero-salpingography, using the technic described by Jareho.<sup>5</sup> Bilateral occlusion of the oviducts at the cornua was demonstrated. (Fig. 5.)

On January 18, 1939, I reconstructed both oviducts and demonstrated their resultant patency under direct vision by the technic

described above and illustrated by Figures 1 to 4 inclusive.

The patient missed her July, 1939, menstrual period.

March 18, 1940, demonstrated the patency of the right tube only. (Figs. 6 and 7.)

On May 1, 1942, the patient submitted herself to another operation. At this time I further

FIG. 1.

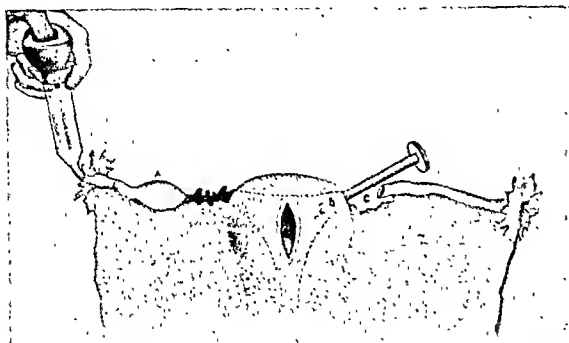


FIG. 2.

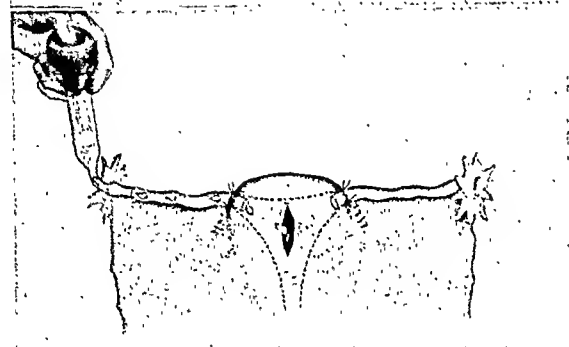
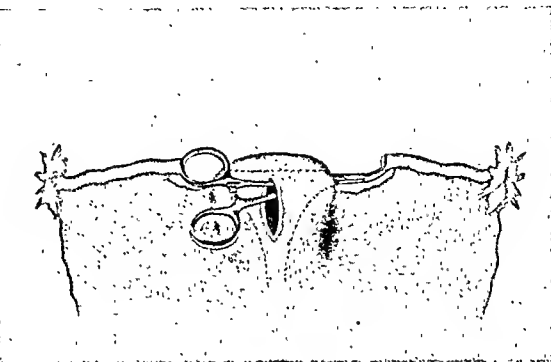


FIG. 3.

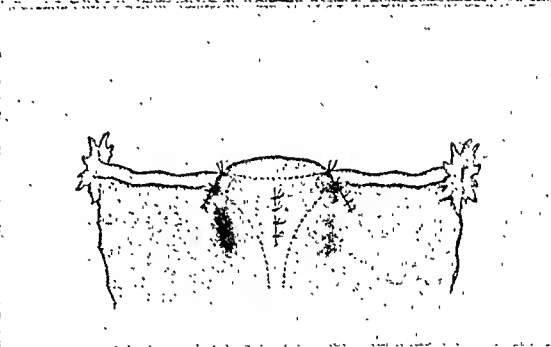


FIG. 4.

FIG. 1. A, illustration of occlusion at isthmus by retrograde insufflation of air (Curtis). B, incision on anterior surface of fundus, exposing the uterine cavity (Solomons). C, occluded portion of oviduct is excised; n, oviduct channel widened at cornual end of uterus by means of a boring instrument (Holden and Sovak).

FIG. 2. Illustrates how small hemostat is passed through the anterior fundal opening, through the reamed out cornual channel, and is then gently made to grasp one lip of the resected oviduct.

FIG. 3. Illustrates resected oviducts sutured snugly in place. All sutures are on the outside of the uterus. Note: As little encroachment as possible is made upon the endometrial cavity. I now resect only one oviduct. Retrograde instillation of sterile normal saline proves the patency of the oviduct under direct vision. This patency is maintained by weaving a strand of plain No. 0 catgut through the reconstructed tube (Solomons). The catgut is absorbed in due time. The catgut is not shown in the illustration.

FIG. 4. Anterior fundal opening closed and leaves of broad ligament are sutured so no defects are left. (Figures 1 to 4 drawn by Tela Benz.)

On September 15, 1939, the Friedman modification of the Aschheim-Zondek pregnancy test was performed and reported positive after a vaginal bleeding episode which had lasted three days without any perceptible loss of the products of conception.

In November, 1939, the patient, presumed to be in her sixth month of gestation, had another episode of vaginal bleeding. No products of conception could be demonstrated and a pregnancy test done at this time was reported negative. Regular menstrual periods ensued.

Another uterosalpingography performed

resected the right oviduct, using the above technic again. I also resected the remains of the left oviduct and transplanted the left ovary over the left cornua (Estes' operation). The patient has not become pregnant.

CASE II. (History No. 73038): The patient, a white female, aged twenty-six, married one year and four months, first presented herself for examination October 26, 1941. Her chief complaint at this time was lower abdominal pain. Her last menstrual period had occurred October 9, 1941, and she had aborted two months prior to that. A physical examination at this time revealed a markedly retroverted

uterus and a mild secondary anemia. She expressed the wish to have children and wished to know what could be done about it.

On May 6, 1943, I performed an appendectomy (the pathologist, Lt. J. Churg, reported a chronic obliterative appendicitis). Retrograde



FIG. 5. CASE 1. November 21, 1936; uterosalpingography disclosed bilateral occlusion of the oviducts at the cornua.



FIG. 6. CASE 1. March 18, 1940; uterosalpingography disclosed left oviduct again sealed off at the cornua, while the right oviduct is still patent.



FIG. 7. CASE 1. March 19, 1940. Twenty-four-hour plate, discloses the lipiodol mainly on the right side of the pelvic cavity, with a good bit of it trapped among adhesions.

I recommended another trial at pregnancy and stated that if she became pregnant again and again aborted I would recommend dilatation of the cervix, curettement, and ventral suspension of the uterus.

On May 5, 1943, the patient had another attack of lower abdominal pain. She stated that she had had recurrent attacks since the October, 1941, visit. I made a diagnosis of appendicitis, recommended immediate operation, and also stated that I would do what I could to correct the infertility since the patient had not become pregnant and both she and her husband were desirous of having children.

insufflation demonstrated dense adhesions about both oviducts and a cord-like formation of the oviducts at the cornual ends. I then performed a right tubal reconstruction in accordance with the technic already described and left a strand of plain No. 0 catgut in the newly opened right oviduct. This was followed by a ventral suspension of the Gilliam type.

No pregnancy had taken place by November 1943. I, therefore, performed a uterosalpingography (Nov. 23, 1943) and was able to demonstrate that the right tube was definitely patent and it appeared that the left tube had been

also opened by the pressure of the lipiodol. The patient had one menstrual period following this procedure (December 10, 1943).

On February 5, 1944, the patient began to stain, so she states. Examination revealed no evidence of bleeding. I hospitalized her, however, and administered 0.2 Gm. of progesterone intramuscularly every other day for three doses. During her stay in the hospital a Friedman modification of the Aschheim-Zondek pregnancy test was performed and was reported strongly positive.

The patient was delivered of a normal male infant on September 1, 1944, by Dr. Eakle W. Cartwright, in Pasadena, California.

*Comment.* One should not be content with reconstructing the oviducts and establishing their patency. If pregnancy does not ensue within four months following such reconstruction, one should insufflate the tubes or do a uterosalpingography. I prefer the latter method because one may then visualize sites of obstruction if any have recurred. Further, one should always bear in mind the possibility of extra-uterine pregnancy following any of the diagnostic and operative procedures used in the study and correction of female infertility. This unwelcome sequel has been reported by Rubin,<sup>6</sup> Elinek,<sup>7</sup> Sovak,<sup>8</sup> and Polowe.<sup>9</sup>

## SUMMARY

A new technic for the reconstruction of the oviducts is described. By its means, the patency of oviducts is established under direct vision of the surgeon. Two successful cases are reported.

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# NON-SPLINTING TREATMENT OF ELBOW JOINT INJURIES\*

## A REPORT OF ITS USE IN TWENTY CASES

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CONVENTIONAL methods of treating injuries and fractures about the elbow joint leave much to be desired. These injuries are often followed by undesirable sequelae ranging from various degrees of dysfunction to the dreaded ischemic contractures of Volkman. Downer<sup>1</sup> states that "at the Alexander Blain Hospital conventional splinting of elbow joint fractures has not led to entirely satisfactory results by any means." This is true in the experience of numerous other surgeons.

Gould,<sup>2</sup> as quoted by Neuwrith, believes that these complications are often due to the generally accepted methods of treatment. He says: "The most successful treatment is prevention, and this means avoidance of circular bandages and avoidance of acute flexion in the presence of swelling."

Neuwrith,<sup>3</sup> in 1942, presented five cases of fractures about the elbow joint treated by placing the arm in a sling and by encouraging early active and passive motion. He was stimulated to attempt this unaccepted method of treatment by the poor results obtained in a case in which the usual splinting procedure was used.

The following types of fracture were treated with excellent results in his series:

Case 1. (a) A comminuted fracture of the lateral condyle with slight displacement upward, laterally and backward extending through the lateral portion of the capitulum into the joint proper. (b) Simple

avulsion fracture, medial epicondyle, with displacement downward and backward.

Case 2. Simple comminuted fracture through the base of the olecranon process of the left ulna, the fragments being in good position.

Case 3. Simple comminuted fracture of right clavicle and simple comminuted fracture of the olecranon process of the right ulna.

Case 4. Simple complete fracture of the epicondyle of the left humerus and simple complete dislocation of the left elbow.

Case 5. Comminuted fracture through the head of the left radius with no appreciable separation of fragments.

On the basis of these cases he said: "It is my opinion that the non-fixing type of treatment in fractures of the elbow may be applied in all cases with profit and with greater restoration of normal function and should be the rule, with fixation and splinting the exception." His conclusions were these: (1) Since the fractured segments in fractures of the elbow are not long enough to be manipulated in reduction, the non-fixing methods should be the treatment of choice. (2) Interference with the circulation about the elbow, brought about by the application of plaster casts, tight bandages, and the like, is responsible for many of the complications and the high degree of dysfunction resulting from the fixation treatment. (3) Greater restoration of function was attained by this method in the series of cases presented. (4) The

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method may be used in the treatment of children as well as adults.

O'Donoghue<sup>4</sup> has taken exception to these conclusions and believes that all elbow joint injuries cannot be lumped together and be treated by this method routinely. It is his opinion that five cases is not a large enough series upon which to base such broad conclusions and that the treatment of these injuries should not be oversimplified. He says: "It may well be that nonsplinting may be the answer to many types of fracture of the elbow. Certainly, I believe that there are many types of fractures to which it will not apply. Let us hope that it will not be adopted indiscriminately until more research has been carried out as to its indications and advantages."

The following is a report of twenty cases to which the principle of non-splinting has been applied, either to the exclusion of or in conjunction with other therapy. We believe that our results in these cases have been astonishing as compared with the results in patients whom we have treated with splinting methods. The series was started independently of Neuwrith's work because of the following experience of one of us (T.A.B.):

#### CASE REPORTS

In September, 1941, a seventy-nine year old white male was admitted to the Redford Branch of the Detroit Receiving Hospital with a compound comminuted fracture of the lower end of the humerus caused by a fall down the stairs. The x-ray report was as follows:—"there is a 'T' fracture of the lower end of the humerus. In the AP view there is considerable widening of the joint because of separation of the condyles. In the lateral view the shaft of the humerus is displaced backward about 60%. The position is not good."

The patient was taken to the operating room and the wound was thoroughly débrided and irrigated under local anesthesia. This was used because the patient was elderly and in shock. The wound was dressed without suturing after small spicules of the bone were removed. Because of the patient's poor condition, the

fragments were not readjusted. The neurological examination was entirely negative. The patient was given combined antitetanic and gas bacillus serum and sent to bed with his arm in a sling. The following day a check ray was taken and there was a question of *Bacillus Welchii* infection. Consequently, splinting was delayed until the possibility of *Bacillus Welchii* infection was ruled out. It had been decided upon reviewing the original x-rays that a splint would be applied in the position of optimal use and the joint be allowed to ankylose. However, after several days had elapsed and the possibility of *Bacillus Welchii* infection had been ruled out, it was noted that there was some voluntary active motion of the injured elbow on the part of the patient. Therefore, he was urged to continue both active and passive motion and was observed closely in the hospital and in the out-patient department for a considerable period of time. The patient was discharged to the out-patient department on September 17, 1941. An x-ray taken on January 30, 1943, showed: "Right elbow—there is an old completely healed 'T' fracture of the lower end of the humerus. Fragments are in good position and alignment." The function in this joint was about 90 per cent perfect. The following pictures illustrate the range of motion obtained. (Figs. 1 to 4.)

While the patient was still in the hospital, it was decided to use the non-splinting method of treatment for other fractures about the elbow joint because of the excellent results noted, and because of the dysfunction so often encountered in the past with splinting methods.

In all the following cases it was obvious during the first few days that the patients were timid about active and passive motion. Consequently, especially in the younger age group, close observation was necessary. All the patients were encouraged to take the arm out of the sling four or five times a day and carry out either active and/or passive motion (all positions). The earlier the motion the better and more rapid was the restoration of function.

A triangular sling (Vernon<sup>5</sup>) was used for all the injuries about the elbow joint. Splinting methods were used in only four cases in this series, two of these being cases in which open reduction was necessitated. For the sake of convenience these cases are divided into two groups. Group 1 is composed of cases in which the displacement of fragments was minimal

or absent and in which the non-splinting treatment was used exclusively. Group II is composed of the more complicated cases.

joint was exquisitely tender and surrounded by marked ecchymosis. The x-ray report was as follows: "Right elbow—there is a supra-

FIG. 1.

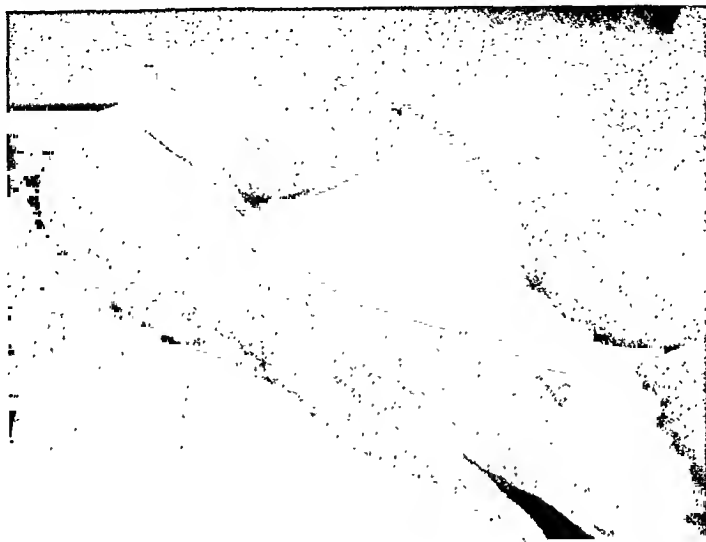


FIG. 2.

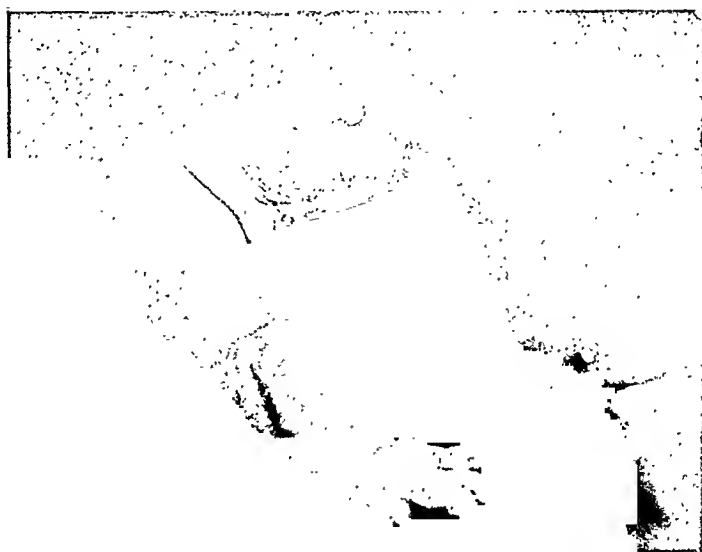


FIG. 1. Pronation.

FIG. 2. Supination.

GROUP I—CASE I. B. H., a seventeen year old white female, was admitted on May 3, 1942, after injuring her right elbow in a fall while ice skating. An x-ray revealed: "Complete linear fracture of the head of the radius with fragments in perfect position." She was followed for a period of several months in the out-patient department and discharged with perfect function.

CASE II. J. L., a six year old white female, was seen on June 21, 1942, after having fallen, injuring her elbow, while at home. The elbow

condylar fracture of the humerus in perfect position." The patient was seen several times in the out-patient department and was discharged on July 24, 1942, with perfect function.

CASE III. C. S., a six year old white male, was seen on August 2, 1942, after having injured his left elbow in a fall from a tree. The x-ray revealed: "Left elbow—there is a juxtaepiphyseal supracondylar fracture of the lateral condyle of the humerus with slight anterior angulation of the distal fragment and the epiphysis of the capitellum."

The patient was followed in the out-patient department until October 17, 1942 at which time he was discharged with perfect function.

sion of the lateral condyle of the humerus. This does not exclude a possible epiphyseal injury." He was followed in the out-patient

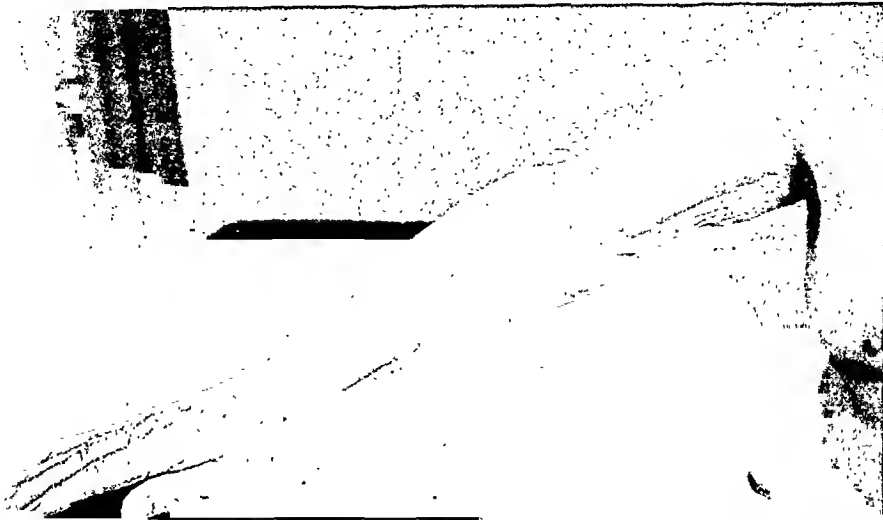


FIG. 3.

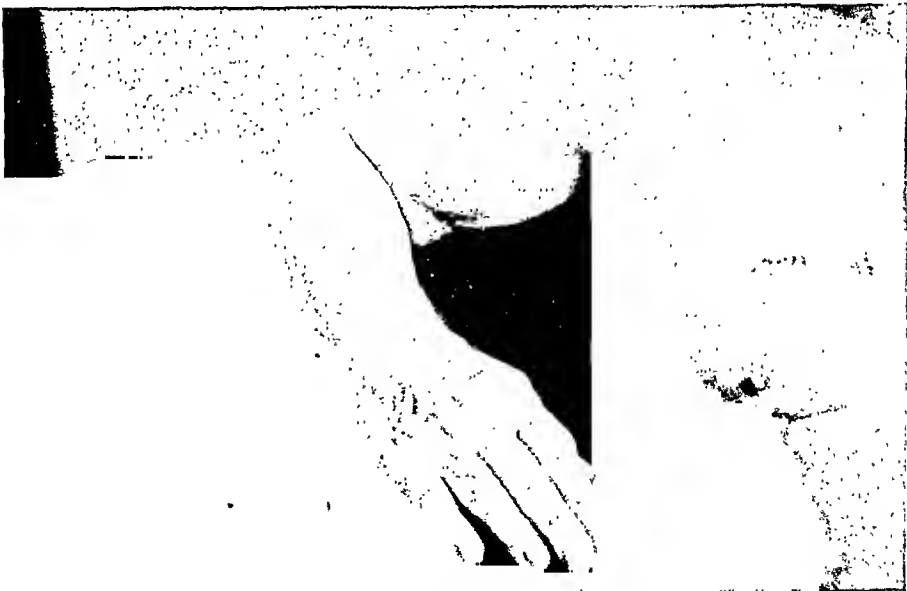


FIG. 4.

FIG. 3. Extension.

FIG. 4. Flexion.

CASE IV. J. W., a fourteen year old white male, was seen on January 14, 1944, after having fallen, injuring his left elbow. The x-ray showed: "Left elbow—incomplete avulsion fracture of the lateral epicondylar epiphysis." The patient was followed in the out-patient department until February 2, 1944, when he was discharged with perfect function.

CASE V. R. B., a fifteen year old white male, was seen on October 23, 1943, after having injured his right elbow while wrestling. The x-ray showed: "Right elbow—small avul-

department until November 13, 1943, when he was discharged with complete function.

CASE VI. C. D., a thirteen year old white male, was seen on October 6, 1943, after having injured his right elbow while playing football. The x-ray revealed: "Right elbow—no apparent fracture. This does not exclude epiphyseal injury." The patient had exquisite tenderness over the medial epicondyle on slightest palpation. The clinical diagnosis was epiphyscal injury. He was discharged on October 20, 1943, with perfect function.

CASE VII. D. S., a sixteen year old female, was seen on March 6, 1942, after having injured her left elbow in a fall from a porch. The x-ray showed: "Left elbow—there is a minute avulsion type of fracture of the coronoid of the ulna in excellent position." She was followed in the out-patient department and discharged in four weeks with perfect function.

CASE VIII. W. R., a sixteen year old female was seen on October 7, 1942, after a fall while riding a bicycle, injuring her elbow. The x-ray showed: "Right elbow—there is no apparent fracture. This does not exclude epiphyseal injury." The clinical diagnosis was epiphyseal injury on the basis of exquisite tenderness. She was seen in the out-patient department for four weeks, at which time she was discharged with perfect function.

CASE IX. R. G., a twelve year old male, was seen on August 17, 1942, after having injured his left elbow while at play. The x-ray showed: "Left elbow—oblique fracture metaphysal portion of the external condyle of the humerus with fragments in good position." The patient was seen on January 30, 1943, after having been followed in the out-patient department, and was discharged with approximately 95 per cent function, there being some limitation of extension. Pronation, supination, and flexion were excellent.

CASE X. J. K., a six year old male, was seen on September 30, 1942, after having injured his right elbow while at play. The x-ray showed: "Right elbow—there is a supracondylar fracture of the humerus with fragments in excellent position." The patient was followed in the out-patient department until January 30, 1943, at which time he was discharged with perfect function.

CASE XI. J. V., a six year old female, was seen on December 31, 1941, after having injured her left arm while at play. The x-ray showed: "Left elbow—there is slight separation of the medial epicondyle of the left humerus." The patient was followed in the out-patient department until March 21, 1942, at which time she was discharged with perfect function.

CASE XII. B. K., a fifteen year old white female was seen on January 7, 1943, after having sustained injury to the left elbow. The x-ray was reported thus: "Left elbow—chip fracture of posterior surface of the lower end of the humerus which has been displaced into the

elbow joint." She was followed for four weeks in the out-patient department and was discharged with perfect function.

GROUP II. Cases in this group were of a more complex nature and four required some degree of splinting.

CASE I. This was the seventy-nine year old male, mentioned previously in this article. Although there was considerable displacement of the fragments, he was treated solely by placing the arm in a triangular sling. As can be seen from Figures 1, 2, 3 and 4 and his x-ray report on January 30, 1943, his final result was excellent.

CASE II. C. B., a white female, age fifty-seven, was admitted to the hospital on March 1, 1943, after falling on and injuring her left elbow. She was obese and had hypertension (220/110). Physical examination revealed the patient holding her left arm with about 90 degrees flexion of the elbow. There was much ecchymosis and swelling with slight deformity and extreme tenderness over the olecranon process. The x-ray showed: "There is a badly comminuted fracture of the upper end of the ulna running obliquely from the base of the coronoid process backward for the posterior-most corner of the ulna. The coronoid process is shattered and both, it and the olecranon, are displaced mesially, while the shaft of the ulna is displaced slightly laterally. The fragments are in poor position." On March 2, 1943, an attempt at reduction was made under sodium pentothal anesthesia. An x-ray showed some improvement in position, but still imperfect reduction. The second attempt at reduction on March 4, 1943, under gas and nitrous oxide anesthesia, was completely successful, and she was discharged to the out-patient department on March 12, 1943. She was seen at three day intervals for several months. On her last visit, July, 1943, there was 90 per cent flexion and extension and perfect pronation and supination. In addition to the reduction of the fragments, the non splinting method was used.

CASE III. F. R., a white male, age fourteen, was admitted January 25, 1943, after falling and injuring his left elbow while playing at school. Physical examination revealed deformity of the left elbow and there was extreme tenderness on the slightest palpation. The x-ray showed: "Left elbow—anterior dislocation of the lower end of the humerus at elbow joint. In addition there is a transverse fracture of the radius at the junction of the upper and

middle thirds with slight anterior angulation." The dislocation was reduced under inhalation anesthesia and a check x-ray showed:—"Reduction of dislocation at elbow joint accomplished. Fragments of radius are in good apposition and alignment." Because of associated fracture of the radius, some immobilization was deemed advisable. A posterior mold was applied from the middle third of the humerus to the finger tips. The patient was discharged to the out-patient department on January 27, 1943. On January 30, 1943, the mold was removed and a short posterior mold, not including the elbow, was applied to the forearm. Active and passive motion was instituted. No vigorous exercises were possible because of the fractured radius. On February 20, 1943 the short mold was removed and vigorous exercises commenced; improvement was gradual. He was discharged on April 17, 1943, with excellent pronation and supination, complete flexion, and about 90 per cent extension.

CASE IV. W. M., a white male, age twelve, was admitted June 16, 1943, after injuring his left elbow in a fall from a tree. Physical examination revealed deformity and pain on palpation in the region of the left elbow. The x-ray revealed: "Left elbow—distal end of humerus is dislocated laterally at the elbow joint. There is a linear calcium shadow under the distal end of the humerus which could represent an avulsion fracture but from the present films the donor site cannot be visualized. The possibility of epiphyseal injury cannot be excluded at this time." Reduction, with inhalation anesthesia, under the fluoroscope was done and a posterior mold applied. A check x-ray after reduction showed that almost perfect relationship had been re-established. He was discharged to the out-patient department on June 17, 1943, and on June 19, 1943, the posterior mold was removed. Active and passive motion was started, and he was discharged on July 24, 1943, with perfect function.

CASE V. B. T., a white male, age thirteen, was admitted on June 12, 1943, after falling from a bicycle and injuring his left elbow. Physical examination showed swelling with apparent deformity and the hand held in pronation. The x-ray showed: "Left elbow—AP and lateral views show complete transverse fracture through the distal end of the shaft of the lateral portion of the humerus, with detachment of supracondylar fragment and capitellar epiphysis and displacement of frag-

ment upward, laterally, and posteriorly." Reduction was carried out under general anesthesia and a posterior mold applied from the middle third of the humerus to the wrist. A check x-ray showed: "After reduction, an excellent anatomical realignment has been obtained." The patient was discharged to the out-patient department on June 14, 1943. The splint was removed on June 19, 1943, and active and passive motion begun. He was discharged on September 11, 1943, asymptomatic and with complete function. In this case a splint was used for seven days.

CASE VI. K. L., a white male, age sixteen, was admitted on December 27, 1943, after having injured his left elbow in a fall while ice skating. The physical examination showed exquisite tenderness over the area of the left medial epicondyle. An x-ray revealed: "Left elbow—there is an avulsion fracture of the medial epicondyle of the humerus which is displaced about 0.5 cm." Management consisted of open reduction and re-alignment of the fragments by use of the single Sherman vitallium screw (1 $\frac{1}{4}$  in.). The postoperative course was uneventful. There was no immobilization, active and passive motion being started immediately. He was discharged to the out-patient department on January 1, 1944, and was followed until February 19, 1944, at which time he was discharged with complete union and perfect function.

CASE VII. F. F., a white male, age five, was admitted on January 8, 1944, after having injured his right elbow in a fall from a bicycle. The physical examination revealed obvious disalignment of the elbow joint with ecchymosis, swelling, etc. An x-ray showed: "Right elbow—there is a trans-condylar fracture of the humerus with almost complete anterior displacement of the shaft of the humerus." Closed reduction was done under general anesthesia. A check x-ray showed the fragments in good position. A posterior mold was applied following the open reduction. He was discharged to the out-patient department on January 9, 1944. The mold was removed on January 22, 1944, thirteen days later, and active and passive motion started. He was last seen on February 19, 1944, at which time excellent pronation and supination was exhibited—about 90 per cent flexion and 70 per cent extension. The patient is still under observation. (Note: The mold was used for thirteen days due to an oversight.)

CASE VIII. M. M., a white female, age thirty-seven, was admitted on July 22, 1942, after having injured her right elbow in falling from a chair. The physical examination revealed a badly swollen, extremely tender elbow with obvious deformity. The x-ray showed: "Right elbow—examination reveals a complete lateral dislocation of the forearm. There has been a badly comminuted fracture of the lateral condyle of the humerus with about 2 cm. posterior displacement." Reduction was done under general anesthesia. A check x-ray showed: "The lateral dislocation of the forearm has been completely reduced. The comminuted fragments show wide separation and rotation. In the cubital fossa there is now a deposit of bony density (1 by 1 cm.) which is thought to be an avulsion chip off the medial condyle as it is on the medial side. There is some posterior displacement of the lateral chip." (The patient was discharged to the outpatient department on July 30, 1942, for observation.) Active and passive motion was commenced but the results were discouraging and open reduction was done on September 30, 1942. The fragment was removed, and non-splinting treatment was continued. She was last seen on January 30, 1943, at which time there was excellent pronation, about 75 per cent supination and flexion and 80 per cent extension.

#### COMMENTS

In a series of twenty cases of injuries of the elbow joint, temporary immobilization was employed in only four cases. In these four cases, periods of immobilization averaged 6.75 days. This average is too high because of the oversight in the case in which the mold was left on inadvertently for thirteen days. In the twelve cases of group I, in which there was little or no displacement of fragments, non-splinting with the triangular sling was used exclusively with excellent results. In addition to these twelve cases, five cases of Neuwrith's<sup>3</sup> are cited. In the eight cases of group II, in which the fractures are more complex,

open reduction was necessary in two cases and temporary splinting in four cases. However, the principles of early active and passive motion were employed in all of these cases with results, which we consider to be superior to the older method. In all cases eventual function of the elbow joint was excellent, and in all cases a triangular sling was used. It is our observation that pronation and supination are the functions which return first. Flexion is next and extension returns last.

#### CONCLUSIONS

1. A series of twenty cases, injuries and fractures about the elbow joint, is presented in which excellent results were obtained in all age groups by the use of the non-splinting method.
2. In fractures and epiphyseal injuries about the elbow joint without displacement of fragments, this is the method of choice.
3. In fractures requiring reduction, occasional splinting was desired for rather brief periods of time (usually under one week)
4. It is recommended that the non-splinting method of treating fractures and injuries about the elbow joint be more widely employed and the results studied. Our results lead us to the enthusiastic support of its use. However, we would caution against the indiscriminate use of the non-splinting method in those complicated cases requiring reduction.

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# ACUTE CHOLECYSTITIS\*

## A COMPARATIVE STUDY OF THE MORTALITY RATE AFTER IMMEDIATE AND DELAYED OPERATIONS

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THE most controversial topic in connection with gallbladder surgery at present, is the management of acute cholecystitis. Recently, a great deal has appeared in the literature on the subject and, as frequently happens in surgery, the writers are divided into three main groups: the radicals who recommend operation on all patients with acute cholecystitis as soon as the diagnosis is made; the conservatives, who advocate deferring operation until all signs of acute inflammation subside. The third group is the middle-of-the-road group who maintain that each patient must be treated individually according to individual indications, not according to any set plan.

Surgeons of outstanding ability and unquestioned sincerity are divided in their opinions as to whether it is better to operate on these patients immediately or after the acute attack has subsided. Each faction advances arguments which merit consideration and which may cause concern to one confronted with the problem.

Among the reasons advanced for immediate operation are that the complications of empyema, gangrene and perforation occur in acute cholecystitis as they do in acute appendicitis; that these complications frequently are not recognized since the severity of the clinical symptoms does not parallel the pathological changes in the gallbladder; that the mortality due to these complications offsets any reduction in mortality which may accrue from delaying the operation. Finally, an immediate operation spares the patient needless pain.

The arguments for delay are that the

analogy between acute cholecystitis and acute appendicitis is not valid in that gangrene and perforation are not as likely to occur in the gallbladder as in the appendix. That, even if perforation does take place, there is far greater probability of the resulting peritonitis being localized by adhesions. Again, that the gravity of any surgical procedure involving the gallbladder requires that the general condition of the patient be as favorable as possible, which is not the case in acute cholecystitis. Finally, the edema of the gallbladder wall during the acute phase makes operation unduly hazardous. It has also been stated that acute cholecystitis may be compared to acute salpingitis rather than to acute appendicitis in that it rarely kills if treated conservatively.

The literature of no other abdominal, inflammatory condition presents so wide a difference of opinion, among surgeons of experience, as to the indications for operation. And among those who advocate immediate intervention there is a marked divergence of views as to the operation of choice.

In an English textbook Walton compared acute cholecystitis to acute appendicitis and insisted upon immediate operation.<sup>1</sup> Bland-Sutton asserts that to operate for acute cholecystitis and not remove the gallbladder is as reprehensible as operating for gangrenous appendicitis and not removing the appendix.<sup>2</sup> Symonds was of the opinion that urgent operation was never called for.<sup>3</sup> Moynihan waits when possible until the interval and then removes the gallbladder.<sup>4</sup>

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In France the Lyons school, led by Leriche and Cotte, insist that this disease be treated by immediate cholecystectomy. The subject was discussed at two sessions of the Lyons Surgical society in 1923.<sup>5</sup> It appears from this discussion that the conduct which then prevailed in France was to practice a minimum of intervention during the acute attack. In case of emergency a cholecystostomy was performed to be followed by a secondary cholecystectomy.

A few years later the pendulum swung to the other extreme and the tendencies in France were in favor of an intervention without delay in the course of a serious attack of acute cholecystitis.<sup>6</sup> However, the nature of the intervention was still the subject of active discussion. Lecene felt that cholecystectomy has undeniable advantages but, because it may be dangerous, was content to practice cholecystostomy under local anesthesia in many cases.<sup>7</sup> Pauchet recommended drainage in the acute stage to be followed, after disappearance of infection, by removal of the organ.<sup>8</sup> Cuneo took the position which seemed to be fairly common among French writers, that if the whole gallbladder wall is involved in the inflammatory process (pancholecystitis of Lecene) drainage alone is not enough to stay the process of the acute disease.<sup>9</sup> Gaudin was impressed by the results of immediate cholecystectomy and believed that the subserous removal during the acute stage presents no notable difficulties for any operator, however lacking in experience he may be.<sup>10</sup> Savariaud held that both operations have their indications but he also practiced cholecystoenterostomy in certain cases.<sup>11</sup>

Most German surgeons appeared to favor deferring operation until the interval except in the face of progressive phenomena in the acute attack; and then operation is indicated.<sup>12</sup> In March, 1927, Duhrssen stated that this was the practice at the Berlin Charite where operation is performed eight days after the disappearance of the last acute symptoms; perforation, icterus with grave infection and involve-

ment of the peritoneum being absolute indications for interference during the attack.<sup>13</sup> In 1924, the Medizinische Klinik published the results of a questionnaire covering the subject, which had been submitted to the leaders of German surgery. While the majority of the surgeons preferred postponing operation until the acute stage had passed, practically all of them operate if the symptoms are unusually severe.<sup>14</sup> This appears to be the position of Enderlen, Kuttmer, Kappis, Schmieden, Perthes, Anschnetz, Laewen and Koerte. Kirschner is the chief German protagonist of early cholecystectomy.<sup>15</sup>

American surgeons are also divided in their views on this subject. Haggard claimed that the rarity with which patients ever die from an acute cholecystitis when left alone should compel us to avoid operation in the acute stage, which is notoriously dangerous.<sup>16</sup> McGuire believes there is no general rule to guide one in these cases and, unless the condition be attended by symptoms which cause alarm, is in favor of waiting until the acute process subsides.<sup>17</sup> Deaver wrote that when possible the operation should be deferred until subsidence of the acute attack but if interference be demanded cholecystectomy be performed.<sup>18</sup> Lyons and Judd wrote in 1923 that if the condition is acute it is better to wait until the attack subsides before operation.<sup>19</sup> Behrend taught that one should not operate for empyema of the gallbladder until the temperature has been normal for several days and the gallbladder is freely palpable without pain.<sup>20</sup> Lewis, Mueller, Archibald and Richardson, in 1928, were of the opinion that it is better to let the process quiet down and then operate rather than operate in the acute phase unless an alarming increase in symptoms forced the surgeon's hand.<sup>21-24</sup>

Judd and Philip later adhered to the plan of early operation, except in certain cases in which operation should be deferred for a long time. They also wrote that there can be no certain plan for dealing with this disease.<sup>25</sup> Stone contends that early

operation is advisable in all cases.<sup>26</sup> Smith believes that urgent operation should not be performed without urgent indication.<sup>27</sup> Eliason and North believe that early operation in the course of an attack will reduce both mortality and morbidity.<sup>28</sup>

The etiology of acute cholecystitis is not only interesting but the etiological factors involved are also varied and many. It rarely develops alone. It develops in a non-calculous form as a complication of certain general infections such as typhoid fever, paratyphoid fever or influenza. It may result from infection of the gallbladder by a number of organisms, the relative importance and method of entry of which has been largely studied and upon which points general agreement does not exist. This non-calculous type of acute cholecystitis is extremely rare<sup>29</sup> and may occur both in children and adults.

Acute typhoidal cholecystitis occurs during the course of typhoid or paratyphoid fever in about 1 per cent of cases. It may be encountered in typhoid carriers who may or may not have had typhoid fever clinically. Apparently the *Bacillus typhosus* has a specific affinity for the biliary tract and may persist in this situation when no trace of it can be found elsewhere in the body. In a high percentage of cases it can be cultured from the wall of the gallbladder itself or from its contents.<sup>31</sup> Not infrequently other organisms such as the colon bacillus are alone responsible for the attack.<sup>32</sup>

More frequently acute cholecystitis is a part of a general cholangitis or results from the trauma produced by gallstones.<sup>30</sup> The attack is usually precipitated by bacteria dormant in the organ which is rendered more liable to acute inflammation by certain predisposing factors. The production of stasis by chronic disease of the walls, the irritation of the mucosa by stones or foreign bodies and the obstruction and consequent retention of bile in an infected organ by the passage of stones in the cystic duct or impaction of a stone in Hartmann's

pouch all serve to reduce the resistance of the tissues of the wall to infection.

One other specific form of acute cholecystitic disease should be mentioned although its existence as a pathological lesion in the human is not yet proved. Experimentally Mann has produced typical acute hemorrhagic cholecystitis by the intravenous injection of Dakin's solution.<sup>33</sup> Wakeman has likewise succeeded by the injection of chemical irritants into the gallbladders of dogs.<sup>34</sup> These lesions apparently heal spontaneously leaving no trace of their former presence. Although the significance of this chemical or toxic cholecystitis is not well understood, it is well to bear in mind that chemical disturbances of the blood may be responsible for certain forms of acute or chronic cholecystic disease.

Acute cholecystitis admits of several degrees of severity generally known as catarrhal, suppurative and gangrenous. These pathological changes are so frequently blended or associated with diseases of the liver, pancreas or appendix that the classical types may be confusing.

In its mildest forms there may be no visible changes in the gallbladder beyond a little swelling of the mucosa which microscopically shows lymphocytic and leucocytic infiltration of varying degree. Later, this extends throughout the wall which becomes edematous, soft and congested. The serosa exhibits a network of vessels, loses its sheen and readily adheres to surrounding structures. The mucous membrane is congested, covered with sticky mucus and may show small ulcerations. Serous, fibrinous, or bloody exudate alters the color of the bile correspondingly and renders the organ tense and distended.<sup>35</sup>

Progression of the disease process shows replacement of the contents with bile or blood stained pus; suppurative cholecystitis. Finally, the mucous membrane becomes shaggy and necrotic and in places is shed entirely, leaving granulating areas or dark red, greenish or blackened patches of gangrene penetrating to the serosal sur-

face. These areas of impending perforation are more common near the fundus and are associated with the pressure of stones or other factors interfering with the nutrition of the walls. In the most severe cases, particularly if the cystic artery be occluded, gangrene of the entire wall ensues and perforation results. Localization of the process with abscess formation is the rule. Generalized peritonitis following perforation of the gallbladder is of low incidence.

The natural course of acute cholecystitis is subsidence without perforation leaving the gallbladder adherent to adjacent viscera or omentum but with chronic infection firmly established in its walls. Occasionally, impaction of a stone in the cystic duct is followed by absorption of the inflammatory products and hydrops of the vesicle. Alternatively, acute catarrhal or suppurative cholecystitis may be followed by empyema. Fistulas of all types may result from perforation into adjacent viscera.<sup>36</sup>

Acute hepatitis, or, generalized non-suppurative infection of the liver is frequently observed in connection with acute cholecystitis. The liver is swollen, edematous and on microscopic section shows diffuse lymphocytic and leucocytic infiltration of the portal spaces. Evidences of infection in the gallbladder may not be pronounced and, as Graham, Peterman, D. P. D. Wilkie, Moynihan and others have pointed out, may indicate that the disease is primary in the liver and secondary in the gallbladder.<sup>37</sup>

In reading the recent literature one is struck by the probability that the various authors have different concepts as to which cases should justly fall into the classification of acute cholecystitis. Therefore, at this point, a definition of what cases are to be considered as such will be offered. In this series only those patients who presented on admission, fever, leucocytosis and pain, tenderness and rigidity over the gallbladder area will be considered as acute. The gross pathological specimen at the time of operation is taken as the final criterion as to

whether or not the case was to be included in this study.

As stated above, the treatment of acute cholecystitis is a controversial subject at present. There are many advocates of immediate operation and of delayed operation. It is important to decide whether patients afflicted with this disease do better with immediate operation or delayed operation. It is also a matter of interest to the surgeon to know what percentage of cases of acute cholecystitis fail to subside under conservative management. Is there any method of predicting in which cases the process will not subside and in which it will? If emergency surgery is thought necessary, what procedure should be carried out?

Those who adhere to the conservative policy maintain that early in the disease the infection is not limited to the gallbladder and that manipulation incident upon operation may result in spreading the infection, thus producing general abdominal sepsis. The gallbladder is so situated that it is well protected by omentum, colon, liver and peritoneum. During the waiting period protective adhesions are formed and the infection becomes limited to the gallbladder. Perforation of the gallbladder is infrequent and when it does occur it is usually late in the course of the disease when the protective adhesions will limit the spread of infection. They contend that existing infection increases the danger of operation during the attack period.<sup>43</sup>

However, these same proponents of the conservative management of this condition admit that the "watchful waiting" policy can by no means be adopted as an invariable rule. Each case must be considered individually and at the end of each twelve-hour period of observation the question of further policy decided upon. If there be evidence of progression of infection as shown by increasing fever, leucocyte count, pulse rate, increase in size of the tender area together with muscle spasm operation should be performed without further delay. Gangrene of the gallbladder demands im-

mediate operation. Its diagnosis is difficult but its existence should be suspected when all the usual signs of acute cholecystitis are exaggerated and rapid progression occurs during a short period of observation.<sup>38-42</sup>

It was mentioned previously that only those patients who presented on admission fever, leucocytosis and pain, tenderness and rigidity in the gallbladder area will be considered in this series. These symptoms and signs must have been confirmed by pathological findings at operation before the diagnosis is considered complete.

One hundred twenty-three such patients have come to operation at this hospital in the past decade. Each case fulfilled the clinical and pathological requirements in order to be included in this study. Cases which were clinically acute cholecystitis but who were discharged without operation for one reason or another are not included. There were no patients who were clinically acute cholecystitis who died without operation having been performed.

Of the total of one hundred twenty-three cases there were ninety-eight females and twenty-five males. The different ages of the patients varied from twenty-one to seventy years, the average age being 46.5 years.

The outstanding and most bitterly complained of symptom was pain. Pain was present in one hundred fifteen or 93.4 per cent of the patients. Tenderness led the list of the signs and was present in one hundred eighteen of the patients. Rigidity over the gallbladder area was present in ninety-eight of the patients. Thus, as in acute appendicitis, acute cholecystitis presents pain, tenderness and rigidity, although different in location, as the most typical clinical picture. A palpable mass was present in the gallbladder area in forty-one patients. The admission temperature ranged from 99.2°F. to 104.2°F, the average for the whole series being 100.8°F. The average leucocyte count was 12,275 white blood cells per cu. mm.

For purposes of study and analysis the series of cases will first be divided into groups depending on the duration of symp-

toms, according to the history, prior to operation. Thus, the entire series may be divided into the following groups:

Group	Interval between Onset of Symptoms and Operation	Number of Cases
I	within 48 hours	22
II	48-72 hours	17
III	72-96 hours	20
IV	96-120 hours	24
V	120 hours to 7 days	23
VI	8 to 10 days	17

When classified in the above manner the table offers one a bird's eye view of all cases of acute cholecystitis that came to operation in this hospital in the past decade. Because this paper is a comparative study of the mortality rate in acute cholecystitis after immediate and delayed operation the cases have been arranged in groups according to the number of hours after onset of symptoms operation was performed. The cases in each group are arranged according to clinical data, operative procedure, pathological changes found in the gallbladder, postoperative course and mortality. An analysis of the Table will show how the mortality rate has varied from interval group to interval group.

All patients received essentially the same preoperative treatment: morphine hypodermically, ice cap to the abdomen, and parenteral infusions of glucose solutions to combat dehydration and fortify the liver. The amount of preoperative treatment depended, of course, upon the interval between admission and operation.

The postoperative management of all patients was also similar in kind: morphine for pain and glucose solutions to maintain water balance and to supply sugar to the liver.

In all six groups the average ages ranged from forty-two to fifty years, the individual ages of all cases in the series varying from twenty-one to seventy years. Obviously, with such a wide span between the extremes in age in the whole series, the average age

in each interval group would hold no clue as to the optimum time to operate in each individual case. In general, however, it is true, as in other branches of surgery, the risk of operation in acute cholecystitis is increased in the upper age groups for the same reasons the risk is increased in *other branches of surgery*.

The average temperature readings show elevations in all six groups but in the last three groups the elevations are not alarming. It is in the first three groups that the mortality rates are the highest. In each of the first three groups the greatest number of pathological changes are not gangrene of the gallbladder (the most serious form of inflammation prior to perforation) but are catarrhal and suppurative inflammations. In view of this, it may be that the more marked increase in temperature is not caused by the severity of inflammation in the gallbladder but by some degree of so-called "liver shock" incident upon the onset of acute inflammation. Dehydration may be ruled out as a cause of fever because, preoperatively, measures were taken to overcome dehydration by the parenteral infusions of glucose solutions. In all instances in which death resulted hyperthermia and gradually deepening coma composed part of the picture. Indeed, the clinical picture resembled that syndrome which is now being described as "liver shock." It is quite permissible to philosophize a bit and reason that in these fatal cases a liver already damaged by the onset of inflammation and not given an opportunity to recover from the initial insult was not able to bear the added burden of operation and failed, the patient succumbing to "liver shock" or "liver failure."

The average leucocyte count varies from group to group. If one considers the normal count to be 5,000 to 10,000 white blood cells per cu. mm. the average count is elevated in all groups. The average count is more markedly elevated in the first four groups but in no group is it remarkably high. Considered from the standpoint of "average count" no clue is found as to

when to operate. However, one certainly must be influenced by individually high counts in each particular case especially if successive counts show increasing numbers of white cells in conjunction with increase in severity of symptoms and signs. This would indicate the pathological condition is progressing and perforation of the gallbladder with resultant complications is imminent or at least threatened.

In the earlier part of the past decade it was the policy in this hospital to operate upon all patients with acute cholecystitis after a short period of preoperative treatment. The operation usually performed was cholecystostomy. Cholecystostomy is a less radical and more easily borne operation than cholecystectomy but, even with this almost definite routine, the mortality rate was so discouraging that fewer and fewer patients were operated upon immediately and the operation of choice was considered to be cholecystectomy.

With past experience in mind all patients are treated expectantly and surgery is not advised unless the patient does not respond to treatment or the condition has clinically subsided. With this policy our mortality rate has been reduced from 13.6 per cent in Group 1 to zero in the last two Groups. Of course, there have been patients who were treated expectantly and failed to respond to treatment. These patients were then subjected to emergency surgery. In view of the lowered mortality rate it would appear that more prolonged preoperative treatment is a factor in reducing the death rate. Cholecystostomy is now used only in old individuals whose condition is such that a more extensive operation procedure is contraindicated on the basis of age and debility alone.

In contrast, the number of cholecystostomies performed in Group 1 is only two more than the number of cholecystectomies performed in the last group. But the last group yielded a mortality of zero while the mortality in Group 1 was 13.6 per cent (one of the deaths in Group 1 was a patient upon whom a cholecystectomy was done).

This would seem to indicate that the more radical procedure is better borne by the patient after a period of delay than the less radical operation performed immediately.

Because of the comparative figures as depicted in the Table and because of the type of operation performed and the interval in which it was performed, we believe that cholecystectomy after a period of pre-operative treatment is the procedure of choice. At the same time, however, a careful watch is maintained and if the patient does not respond to treatment we do not hesitate to intervene.

and symptoms are concerned. Perforation of the gallbladder with cholecystic abscess is also known to undergo retrogressive changes in which the abscess becomes better walled off and more chronic in nature with disappearance of clinical manifestations of disease.<sup>44</sup> Some authors include only cases of gangrene and perforation as "irreversible pathology" while others include the more virulent cases of acute cholecystitis. However, even if all these manifestations are considered as "irreversible" they do subside clinically and thus the term "irreversible pathology" does not

	Group I		Group II		Group III		Group IV		Group V		Group VI	
Number of cases.....	22		17		20		24		23		17	
Average age.....	49		52		42		45		41		50	
Average temperature.....	101°F.		100.6°F.		99.8°F.		99.2°F.		99.2°F.		99°F.	
Average leucocyte count.....	12,500		14,500		13,000		12,500		11,000		10,250	
	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
Operative Procedure												
Cholecystostomy.....	19	86.4	13	76.5	6	30	2	8.3	0	0	0	0
Cholecystectomy.....	3	13.6	4	23.5	14	70	21	87.5	22	95.7	17	100
Simple drainage.....	0	0	0	0	0	0	1	4.2	1	4.3	0	0
Pathological Changes												
Acute catarrhal.....	13	59.1	8	47	10	50	1	4.2	0	0	0	0
Acute suppurative.....	6	27.3	3	17.7	4	20	4	16.7	1	4.3	3	17.6
Acute gangrenous.....	3	13.6	5	29.4	1	5	1	4.2	0	0	0	0
Empyema.....	0	0	1	5.9	5	25	15	62.5	13	56.5	1	5.9
Hydrops.....	0	0	0	0	0	0	2	8.2	4	17.4	8	47.1
Perforation with abscess formation...	0	0	0	0	0	0	0	0	1	4.3	0	0
Perforation with generalized peritonitis	0	0	0	0	0	0	1	4.2	0	0	0	0
Subacute or chronic.....	0	0	0	0	0	0	0	0	4	17.4	5	29.4
Postoperative Course												
Smooth.....	11	50	10	58.8	16	80	20	83.3	21	91.3	15	88.2
Stormy.....	11	50	7	41.2	4	20	4	16.7	2	8.7	2	11.8
Mortality.....	3	13.6	2	11.8	1	5	1	4.2	0	0	0	0

The pathological changes encountered at operation varied from the relatively mild acute catarrhal cholecystitis to perforation of the gallbladder with cholecystic abscess or generalized peritonitis. At operation it is usually impossible to tell whether the inflammatory process is advancing or subsiding. Yet, there is ample clinical evidence to the effect that the conditions of simple acute cholecystitis, empyema and hydrops do subside spontaneously as far as signs

necessarily mean that the disease is a progressively fatal one.

All sorts of pathological pictures, from the most mild to the most severe, were found. Prescinding from the virulence of the offending organism the determining factor in the degree of severity of the inflammation appeared to be the impaction of a stone in the cystic duct and resultant changes in circulation and drainage of the gallbladder. Thus, if the pressure were

exerted against the cystic artery and vein, the process would tend to proceed to gangrene and perforation. On the other hand, if circulation were good but drainage of the gallbladder shut off by occlusion of the cystic duct empyema and hydrops would result.

In the past it has been a dictum that perforation of the gallbladder is among the rarities of surgical practise. Recent writings do not bear out this contention but would indicate that this complication is more frequently encountered than formerly believed.<sup>45, 46, 47</sup> In this series there were two cases of perforation (1.62 per cent). One was a perforation with generalized peritonitis occurring in Group iv. The other was a perforation with abscess formation occurring in Group v. The incidence of perforation is not small enough to be considered a rarity but it is not as great as contemporary writers have discussed.<sup>45, 46, 47</sup> Kunath reports an incidence of 22 per cent perforations, 3.9 per cent being into the general peritoneal cavity.<sup>44</sup> The possibility of perforation never should be minimized and it is for this reason that a patient treated expectantly should be examined at frequent intervals.

There were ten patients with acute gangrenous cholecystitis who came to operation. It may be quite likely that the pathological process would have progressed to perforation were not the organ removed at this stage. A clinical diagnosis of gangrene of the gallbladder is considered an urgent indication for operative intervention.

In the entire series there were only nine cases, or 7.3 per cent, which had subsided sufficiently to warrant the diagnosis of subacute or chronic cholecystitis. This attests to the fact that the clinical signs presented do not always parallel the pathological picture presented by the gallbladder itself.<sup>48, 49</sup>

It is interesting to note that in Groups iii, iv, v and vi only two cases were gangrenous while forty-two, or half the cases in these groups, were diagnosed as empyema of the gallbladder. This would

indicate, in view of the low mortality rate of these groups, that so-called empyema of the gallbladder is a relatively innocuous condition. Indeed, a number of writers have emphasized the point that cultures of pus from empyema are often sterile.<sup>50, 51</sup> Andrews, in a recent article expresses doubt as to the existence of true empyema, believing that the pus is simply precipitated calcium or cholesterol.

Roughly speaking, patients run a smooth or stormy postoperative course. In the first Group eleven, or 50 per cent, of the patients had a stormy postoperative course as against two or 11.8 per cent, of the patients in the last Group. Between these two were varying degrees of response to operation. The Group in which the postoperative response was most satisfactory is Group v in which only 8.7 per cent of the patients ran a stormy postoperative course.

This thesis being a comparative study of the mortality rate in acute cholecystitis after the immediate and delayed operations, the all important question to decide is under which mode of treatment is the operative mortality lower. But, before deciding this, it must be determined what is meant by "immediate" and "delayed" operations.

The cases studied are divided into groups according to the time elapsing between the onset of symptoms and operation, not according to the time elapsing between admission to the hospital and operation. Thus, the terms "immediate" and "delayed" would seem to apply to the interval between onset of symptoms and operation. However, the terms are modified by the fact that a number of the cases did not come under our observation until the disease process had been present for several days. Therefore, to do away with ambiguity and obscurity on this point, seventy-two hours has been chosen as the dividing line between immediate and delayed operations. All patients operated upon within seventy-two hours after the onset of symptoms are considered to have had immediate opera-

tion, and those operated upon after seventy-two hours to have had delayed surgery.

The mortality figure for the entire series of cases was 5.69 per cent, a figure which compares favorably with other statistics in the literature.<sup>52,53,54</sup> A perusal of the Table will reveal the mortality figure for each of the individual Groups. It has been our experience that the highest mortality figure falls in Group I. The next highest falls in Group II. After that there is a sharp drop, the mortality rate of Group III being half that of Group II. In Group IV there is a slight drop in mortality from Group III. Groups V and VI were free of any mortality.

Although the mortality figure of the entire series is 5.69 per cent, a glance at the Table will show that the greatest number of deaths occurred in the first two Groups; 12.7 per cent of the entire number of patients in these two groups succumbed after operation. These comprised five-sevenths of the total number of deaths in the whole series. Of the remaining eighty-four patients only two, or 2.38 per cent, died. Thus, if seventy-two hours be taken as the line of demarcation between the immediate and delayed operations our mortality rate has been greatly reduced by employing the delayed method.

Contemporary writers differ in their mortality rates. Smith, influenced by his experience at St. Luke's Hospital in New York, believes that immediate operation should not be done without urgent indication and, if the course is favorable under observation it is wiser to wait for subsidence of symptoms.<sup>41</sup> Heuer recommends early operation, giving his mortality incidence as 2.1 per cent unless perforation has occurred prior to operation in which case it was 12.5 per cent.<sup>55</sup> Taylor places the operative mortality at 5 per cent if operation is done during the first four days of the attack and at 24 per cent thereafter. He adds that no case is so urgent that preoperative administration of glucose can be neglected.<sup>56</sup>

Because of this reduction in mortality rate it is now the policy of this hospital to treat acute cholecystitis expectantly. The policy is a flexible one, however, inasmuch as, if there be progression of symptoms and signs, treatment is interrupted and operation, preferably cholecystectomy, performed. Under this plan each case is really individualized. We prefer the delayed operation but at times will operate immediately or during the period of observation if we believe there is danger of perforation of the gallbladder.

#### SUMMARY

1. The treatment of acute cholecystitis has been the subject of much controversy in the past and general agreement on the subject is still lacking.

2. A review of the literature is presented.

3. The etiological factors concerned and the pathology of the disease are discussed.

4. A series of one hundred twenty-three patients operated upon at the Hazleton State Hospital is offered for analysis in Table form.

5. The Table is analyzed from all aspects.

6. The incidence of stormy postoperative courses is lower after delayed operation.

7. The mortality rate after delayed operation is 2.3 per cent as compared to 12.7 per cent after immediate operation.

#### CONCLUSIONS

1. Delayed operation is the method of choice in the treatment of acute cholecystitis.

2. Cholecystectomy is the operation of choice.

3. Each case must be individualized, however, and operation undertaken if perforation of the gallbladder appears imminent.

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# CELLOPHANE IN BONE AND JOINT SURGERY

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SINCE the postoperative adherence of contiguous structures frequently limits the success of operative procedures upon tendons and joints, a technic or substance which would minimize these adhesions is very desirable. McKeever<sup>1</sup> has recently reported a method of using cellophane sheets as an interposition membrane after synovectomy of the knee. These were cut to pattern and placed in the suprapatellar pouch and served to prevent the obliteration of the pouch which commonly follows synovectomy and which limits motion in the joint postoperatively. McKeever<sup>2</sup> has since demonstrated, in an unpublished large series of cases, that cellophane is inert in the tissues and can be allowed to remain in place indefinitely. Thus it would appear to lend itself to a great many uses. The three cases presented in this paper are further evidence that this material is of value in retaining full motion postoperatively by separating raw surfaces which would otherwise become fused by fibrous tissue. The cases represent three entirely different situations in which cellophane may be used to advantage. In none of these patients was there any clinical evidence of departure from normal wound healing. There was no induration or other indication of tissue reaction to foreign material. Silk was used as the suture material in two cases, fine catgut in the other.

The only cellophane readily available to us was that in which cigarette packages are wrapped. This was sterilized by boiling and it was found that the waterproofing material with which it had been treated was easily wiped-off after boiling.

Cellophane of this grade is quite easily torn and hard to handle or to suture. This is not a serious problem, however, as a piece cut to the proper size and shape will

remain in place when lightly sutured or even without suturing.

## CASE REPORTS

CASE I. A nineteen-year-old white soldier was admitted August 9, 1943, because of pain, swelling, and limitation of motion in the metacarpophalangeal joint of the right index finger. He gave a history of a laceration of the dorsum of the joint caused by a bayonet on June 5, 1943. The wound had been sutured promptly. For the next two months he had had a non-suppurative inflammation which had been treated by hot compresses in hospitals in the maneuver area. On examination there was a healed scar over the dorsal aspect of the joint and a tender, fluctuant swelling of the region with slight skin redness. The scar was adherent and active extension beyond 45 degrees of flexion of the finger was impossible. Flexion was also markedly restricted due to the scar.

Three days after admission a repair of the lacerated tendon was undertaken. The scar was excised and the incision enlarged. It was found that the wound had extended into the joint and the synovium had not healed, the free communication of the joint with the subcutaneous tissues and a severe synovitis accounted for the fluctuant swelling. The tendon had been severed and was imbedded in unhealthy appearing granulation tissue. The joint was irrigated, a small amount of sulfanilamide powder instilled, and the synovium closed with fine chromic catgut. The tendon ends were freed, freshened, and sutured with medium silk. A square of cellophane, measuring 1 inch by  $\frac{3}{4}$  inch, was placed between the sutured tendon and the joint and the wound was closed.

Three weeks after operation the splint was removed and active motion begun. Two weeks later the soldier was returned to duty with complete range of active motion and a normal appearance of the joint.

CASE II. A twenty-four-year-old white soldier was admitted June 22, 1943, because of chronic pain, swelling, and marked limitation

of motion in the right elbow. Four weeks earlier his elbow had been forced into hyperextension when his arm was caught between

cellophane, 6 by 12 cm., was cut to fit the raw area and was sutured into the wound so that it completely separated the replaced triceps



FIG. 1. Photograph showing range of flexion four months after excision of calcified mass from triceps tendon and interposing a sheet of cellophane between it and the humerus.

a horse and a gate post. There had been no dislocation or fracture. Examination on admission revealed a post-traumatic stiff elbow with moderate swelling, induration especially in the antecubital fossa, and motion limited to a range between 95 degrees and 120 degrees. The x-ray showed a small amount of periosteal new bone formation adjacent to both condyles of the humerus. After five weeks of treatment, including active physiotherapy and one examination and manipulation under anesthesia, the motion had improved very little and the range was now from 90 degrees to 135 degrees. Subsequent x-ray showed a large increase in the calcification all about the elbow, greatest in the region of the triceps tendon and the medial condyle.

On September 2, 1943, a plastic operation was performed designed to correct the soldier's greatest disability which was his limitation of flexion. A long posterolateral incision was made in the skin, and the triceps tendon and muscle incised in a triangular flap and turned back exposing the elbow joint and the humeral shaft. Large masses of calcified tissue were encountered on the undersurface of the tendon and in the olecranon fossa and these were completely excised including the periosteum. No calcified tissue was left behind. The total mass measured 5 by 2 by 2 cm. A large piece of

tendon from the underlying tissue and the humerus. The triceps tendon was then sutured back into place after lengthening it about one inch by closing the apex of the triangle for this distance. Silk was used throughout the operation. The forearm was held in hyperflexion for one week and physiotherapy was then resumed.

The soldier was returned to duty six weeks after the operation very well pleased with his result. There was no swelling or tenderness and at no time was there any departure from normal wound healing. The range of motion upon discharge from the hospital was from 45 degrees flexion to 135 degrees extension. Re-examination two months later showed normal strength in the arm and motion from 40 degrees to 145 degrees. Motion at the end of four months was approximately the same.

CASE III. A twenty-year-old white soldier was admitted June 20, 1943, with simple fractures in the proximal half of the left radius and ulna. An attempt at closed reduction was unsuccessful, so on July 1, 1943, an open reduction was done and both bones were plated with small stainless steel plates and screws. The bones united in the normal period of time, but in spite of their normal anatomical position, as demonstrated by x-ray after operation, a synostosis had developed between the two bones. On September 9, 1943, through

a new incision, the synostosis was exposed and removed, and a rectangular piece of cellophane, approximately 2 inches by  $1\frac{1}{2}$  inches in size, was placed around the ulnar side of the radius before closing the wound. The cellophane seemed desirable in this case because the excision of the synostosis left a defect in the region of the interosseus septum which would be expected to fill in with an organized blood clot which might recalcify. Active motion was resumed after one week, and the soldier was returned to duty one month later with an approximately normal range of supination and pronation.

#### COMMENTS

The principal reason for presenting these cases is to add additional proof of the value of cellophane as an interposition membrane and to demonstrate the wide variety of uses to which it lends itself. Based upon another author's very extensive experience with cellophane it appears to be entirely harmless and it is to be hoped that its use

in orthopedic surgery will continue to be expanded.

#### SUMMARY

Three cases are reported in which cellophane was used as an interposition membrane with excellent results in each case.

2. In the first case there was an adherent extensor tendon of the index finger which was dissected free and prevented from re-adhering by means of the cellophane.

3. In the second case an adherent triceps muscle at the elbow was kept free post-operatively with a piece of cellophane.

4. In the third case cellophane was placed between the radius and ulna to prevent a recurrence after removing a radio-ulnar synostosis.

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# SULFATHIAZOLE-CODLIVER OIL OINTMENT IN THE POSTOPERATIVE CARE OF THE SEPTIC HAND

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THERE is considerable postoperative morbidity in the treatment of the septic hand with the usual methods. Soft tissue or joint contracture is not an infrequent complication. The purpose of this communication is to present briefly our experience with a new preparation in the postoperative care of the septic hand.

Prophylactic medical care to cuts and minor infections of the hand results in a significant reduction in the number of serious infections. Many serious infections, however, do occur, and upon admission to the hospital some have progressed to a stage dangerous to tendons, to joints and to subsequent function. The bacterial organisms commonly found in these infections are the staphylococci, aerobic and anaerobic streptococci. The parts of the hand involved include all the spaces classically described by Kanavel,<sup>1</sup> flexor and extensor tendons, and the bursae.

Adherence to accepted preoperative treatment is maintained. Hot fomentations, soaks and sulfathiazole are used to obtain localization of infection and in the treatment of the attendant lymphangitis and lymphadenitis. At the judicious moment, the proper and adequate incision and drainage in a bloodless field are performed.

It was previously our practice to pack the incised wound lightly with vaseline gauze or a flat rubber strip, and then apply a voluminous dressing. On return to the ward the extremity was elevated on a pillow, the dressings wet, and the heat maintained by a heat cradle. The moistening agent used was either boric acid, potassium permanganate, magnesium sulfate or an 0.8 per cent aqueous solution of sulfanilamide. Although the results obtained with the latter solution were superior to those obtained with the older agents,

the patient was usually confronted with a prolonged period of hospitalization. It was a problem to determine the point at which the wound was sufficiently clean so that wet heat could be discontinued. Skin maceration in varying degrees was always present. When wet heat was discontinued, the extremity was placed under a heat cradle on a sterile towel, but without dressings, and exercise was begun.

A recent study<sup>2</sup> demonstrated the efficacy of an ointment consisting of 10 per cent sulfathiazole and 10 per cent cod-liver oil in a lanolin base, in the treatment of pilonidal cyst. These experiences suggested that this material might be indicated in the postoperative treatment of wounds of the infected hand. Consequently, the following procedure was evolved and employed in fifty cases of severe hand infection.

At the operating table the ointment was introduced directly into the wound. This was facilitated by squeezing it through a metal ear syringe with tip attached. Neither gauze nor rubber was placed as drains since the ointment, in effect, kept the wound edges separated. An exception to this rule was in the fish-hook type of incisions of the terminal digital space. A fluff of gauze was then smeared with the ointment and placed over the incision. A few additional pieces of gauze were placed over the fluff for reinforcement. The hand was bandaged so that the incision would gape as much as possible to afford certain egress of drainage and melted ointment. For example, incisions on the sides of the fingers, in the palm, or in the thenar space gape most when bandaged so that they are maintained in flexion.

The original dressings were left in place for forty-eight hours. At this time the

dressings were usually sufficiently soiled with drainage to warrant change. The same type of dressing was reapplied but this time loosely bandaged with the hand in the position of rest so that passive and active motion could be started immediately. Hot fomentations were not applied and the patient was allowed to be ambulatory. Thereafter, dressings were done as found necessary except in those cases in which a large necrotic plug, or much tissue débris was present. Separation of the necrotic from viable tissue was hastened by daily soaks in aqueous solution made up of 0.5 per cent clorox. This is a stable cheap commercial chlorine preparation which is satisfactory for this purpose.

#### COMMENTS

Postoperative results obtained by the method employed in the present study were superior to those obtained when wet dressings were used. After forty-eight hours the wounds were clean and a base of healthy pink granulation tissue was present. Lymphangitis and adenitis abated without further specific treatment. Where necrotic tissue was present, it was well defined from the viable tissue and was not covered with a film of foul drainage. In each case movement was possible without the interference of pain. In fact, relief from pain far exceeded the relief which incision and drainage alone affords. This may be attributed to the soothing and lubricating properties of the ointment. These properties likewise contributed to the commencement of early passive and active exercise. This procedure was especially valuable in those cases in which tendons and sheaths were involved and had been exposed by incision. Adhesions about tendons and contractions of soft and bony parts were absent. It is

suggested that the absence of these complications was due to the deletion of abrasive packing and the early institution of motion.

Granulation and epithelization progressed at a rapid rate and complete healing occurred in a much shorter time than previously. Epithelization is particularly important in superficial infections in which skin damage is usually in excess of the severity of the infection. The present observations indicate that the method of treatment described has reduced postoperative morbidity and complications.

The economy inherent in this new method of treatment is obvious. The hospitalization in general is reduced. Demand for postoperative nursing care is at a minimum. Dressings and the time used in doing them are saved. A rehabilitation period in physiotherapy is unnecessary. There is an earlier return to duty.

#### SUMMARY

1. An ointment consisting of 10 per cent sulfathiazole, 10 per cent cod-liver oil in a lanolin base was used in the postoperative wounds of the septic hand. The use of postoperative fomentations was discarded.
2. The infection cleared quickly and consequently healing was more rapid than with previously used methods.
3. Soft and hard tissue contracture did not complicate these cases. It is suggested that the deletion of abrasive packing and drains from the wounds and the early institution of motion is responsible.

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# Case Reports

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## DELAYED RUPTURE OF THE EXTENSOR POLLICIS LONGUS TENDON FOLLOWING COLLES'S FRACTURE

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**R**UPTURE of the extensor pollicis longus tendon as a late complication of Colles's fracture is exceedingly rare. Oppolzer<sup>1</sup> reported two instances of delayed rupture in a series of 800 cases of Colles's fracture, and Moore<sup>2</sup> encountered only three cases in a series of 500 fractures which were treated at the orthopedic department of the Royal Victoria Infirmary at Newcastle-upon-Tyne. Thus the incidence of the complication is roughly once in 250 cases. In a review of the literature in 1940 Kwedar and Mitchell<sup>3</sup> were able to find seventy reported cases to which they added one for a total of seventy-one. The following case brings the total to date to seventy-two.

### CASE REPORT

Miss I. R., age twenty-four, sustained a Colles's fracture of the left wrist approximately five months before her present admission. Films taken at that time were said to have shown the fragments to be impacted and in good alignment; therefore, no manipulation was carried out and no splint was applied to the arm. The arm was carried in a sling for a period of two weeks and active motions of the hand were advised by her attending physician. Following the removal of the sling she had almost normal motion of the wrist with little or no pain. Motions in the thumb, however, were restricted and painful, more so in extreme extension. She continued at her work of file clerk until three weeks before admission, when she began to have pain along the dorsal aspect of the wrist which extended down over the dorsal aspect of the thumb. She was not conscious of any grating sensation in moving the

thumb at this time or any appreciable weakness in the strength of the thumb. Within two days following the onset of the pain, however, she suddenly noticed that she was unable fully to extend her thumb. She was treated by the plant physician with a provisional diagnosis of neuritis without improvement for a period of two weeks, following which she was admitted to this Clinic where a diagnosis was made of delayed rupture of the extensor pollicis tendon following Colles's fracture.

Examination of the left hand showed a typical flexion deformity of the left thumb. (Fig. 1A and B.) The lateral border of the anatomical snuffbox usually formed by the extensor pollicis tendon was missing when either voluntary or passive attempts were made to extend the thumb. Sensation throughout the hand and thumb was normal. Faradic stimulation over the extensor pollicis longus muscle failed to produce extension of the thumb. On palpation of the dorsal aspect of the wrist joint in the region of the groove usually occupied by the extensor pollicis longus tendon there was considerable thickening of the subcutaneous tissue but no definite area of tenderness. Motions at the wrist joint were normal and forceful.

X-ray films (Fig. 3) showed slight forward angulation of the lower end of the radius with a small elevated rounded lip of bone on its dorsal aspect along the site of the previous fracture. The articular surfaces of the joint were smooth. There was no evidence of any abnormal bony prominences. A review of her films taken at the time of fracture (Fig. 2) showed that the fracture was not a typical Colles's fracture, rather that it was more of the reverse Colles's or so-called Smith type, and that there was a definite prominent ridge of

bone on the posterior aspect of the proximal fragment at the site of fracture.

Operation was carried out the following day

molded plaster splint was applied to the forearm and hand, supporting the thumb in extension.

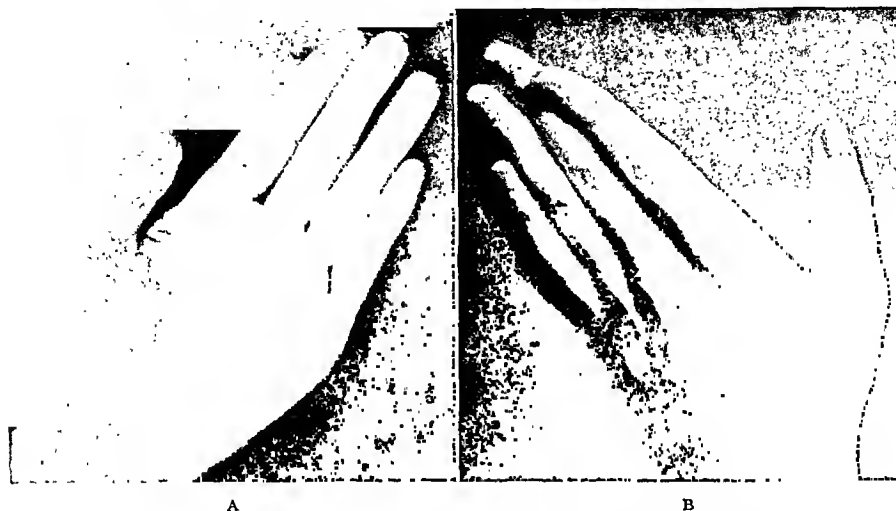


FIG. 1. A and B, flexion deformity of thumb at original examination.

under 1 per cent novocain infiltration anesthesia. A skin incision 3 inches long was made over the course of the tendon on the dorsal aspect of the wrist. The compartment of the extensor pollicis longus tendon was opened. The tendon sheath was somewhat thickened posteriorly. The distal end of the ruptured tendon was located at a distance of approximately  $1\frac{1}{2}$  inches from the proximal end. The proximal end was firmly imbedded in a dense mass of scar tissue which involved the tendon, its sheath and the surrounding tissues in the groove on the dorsal surface of the radius at the level of the previous fracture. The distal end of the tendon was loosely anchored to the sheath by thin, flimsy adhesions. Its end was somewhat rounded and relatively smooth except on its ventral surface where it appeared frayed, suggesting that the dorsal portion of the tendon might have ruptured some time ago and the ventral part torn fairly recently. In view of the extensive inflammatory process present in the sheath and the surrounding structures at the level of the proximal end of the tendon, it was deemed inadvisable to carry out any type of primary suture inasmuch as it would involve replacing the tendon in a mass of scar tissue. Therefore, a tendon transplant was carried out using the extensor carpi radialis longus tendon. Following a biopsy of the distal end of the tendon, the anastomosis was carried out with interrupted fine silk sutures with the thumb in extreme extension. An anterior

Her postoperative course was uneventful and she was discharged from the hospital on the third postoperative day. The splint was removed in three weeks at which time extension of the thumb could be performed to approximately 75 per cent of normal. With slight muscle re-education this rapidly increased to full normal extension. (Fig. 4.) When examined six months following operation, motions and strength of the thumb in extension were approximately normal.

Sections of the biopsy from the distal end of the tendon showed an extensive inflammatory reaction characterized by marked perivascular round celled infiltration with considerable fibrosis. The inflammatory process extended in a somewhat less degree throughout the central portion of the tendon and along its surface. The entire section appeared well vascularized and the vessels did not appear to be thickened. (Fig. 5.)

#### COMMENTS

The rupture of a normal tendon is an exceedingly rare occurrence. Both clinical and laboratory experience have shown that when a tendon is subjected to great strain the site of insertion usually gives way together with a piece of the periosteum before the tendon itself ruptures. When invaded by disease, however, rupture of a tendon is not uncommon and occurs not infre-



quently in infectious tenosynovitis, especially of the tuberculous type. Tendon ruptures following Colles's fracture, as in

not occur until on the average from six weeks to three months following the injury. Duplay<sup>4</sup> reported the only case of immedi-



FIG. 2. Films taken at time of fracture. Note forward displacement of distal radial fragment.

the case reported, have a much more vague etiology, although all of them are usually associated with a trauma to the lower end of the radius. The trauma may be minimal

ate rupture, while, in contrast, Axhausen<sup>5</sup> reported two cases which occurred six and seven years, respectively, after the injury. The part that the time interval plays in

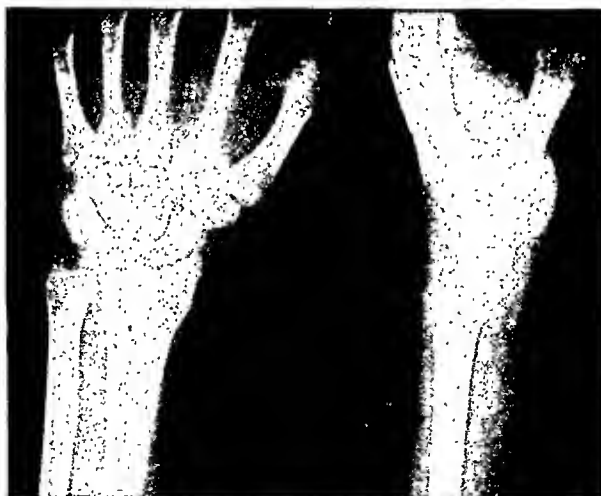


FIG. 3. Films taken at original examination show fracture well healed. Note small ridge of bone on dorsum of radius.

and often is not remembered until the tendon injury occurs.

One common factor in all cases is that the rupture is usually delayed and does

the mechanism of rupture is not altogether clear; however, it suggests that either a certain length of time is necessary for sufficient fibrosis to occur at the site of

injury to interfere with the blood supply of the tendon to cause it to rupture, or that a prolonged period of mechanical irrita-

blood supply are necessary for tendon rupture to occur.

That injury to the tendon and the tendon

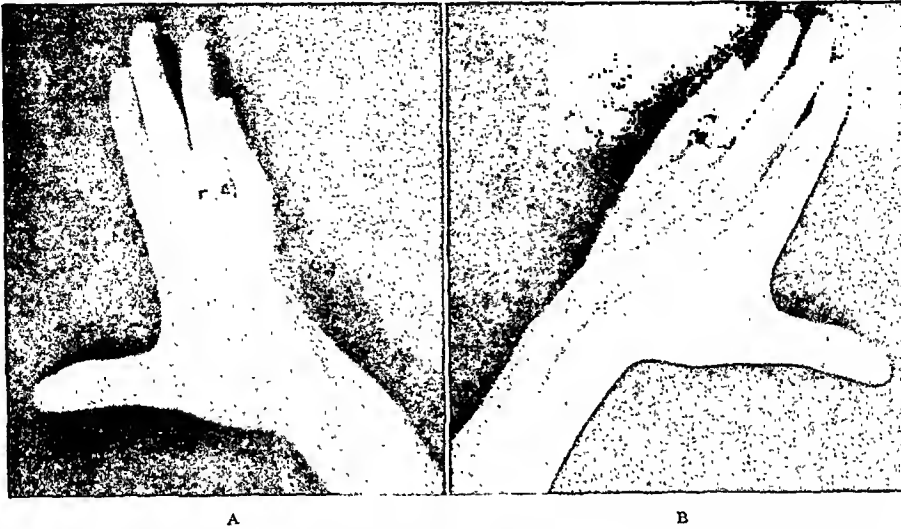


FIG. 4. A and B, appearance of hand six weeks postoperatively; normal extension of thumb.

tion, such as might occur as a result of the movement of the tendon over roughened bone, is necessary to fray the tendon gradually and cause its dissolution. McMaster,<sup>6</sup> in his experiments in tendon and muscle rupture using rabbit's tendon, found that he was able to secure rupture of the tendon only if the tendon had been traumatized and then doubly ligated above and below the site of injury, completely shutting off the blood supply; and then rupture did not occur until an average period of five weeks had elapsed. In the cases in which the tendon was traumatized and no interference with the blood supply carried out, he was unable to produce a rupture at the site of injury even after an interval of five weeks. Ligation of the sheath, associated with trauma to the tendon, did not produce rupture. His work seems to indicate that, in the rabbit at least, a considerable portion of the blood supply to the tendon travels in the tendon itself and that the tendon is more or less independent of the blood supply from the sheath as far as normal repair is concerned. It also lends support to the theory that both trauma and interference with the

sheath does occur as the result of Colles's fracture has been shown by the work of Kleinschmidt<sup>7</sup> who produced experimental fractures of the lower radius, similar in type to Colles's fracture, on cadavers and was able to demonstrate laceration of the sheath and of the tendon of the extensor pollicis longus in every instance, while the other three tendons on the back of the wrist escaped injury. Granted that injury to the tendon and its sheath occurs in every Colles's fracture regardless of the amount of displacement, it is logical to assume that some interference with the blood supply to the tendon and its sheath might develop over a period of time which would gradually lead to rupture of the tendon. That this is the proper sequence of events is borne out by the operative findings in the majority of reported cases which have shown the groove occupied by the tendon to be the seat of a dense inflammatory reaction characterized by firm adhesions usually completely surrounding the tendon and its sheath. The two ends of the ruptured tendon are usually widely separated at distances varying from 5 to 8 cm. Microscopic examination of the tendon, as

in the case reported, shows an extensive inflammatory reaction involving the sheath and its tendon characterized by marked



FIG. 5. Section of distal end of tendon showing perivascular round celled infiltration with dense strands of fibrous connective tissue extending over end of tendon.

perivascular round celled infiltration with a concomitant decrease in the size of the vessels. It is unusual to find areas of definite necrosis, although one case has been reported by Simon<sup>8</sup> in which so-called sterile pus was present at the site of rupture. Several cases have been reported in which small cyst-like accumulations have been present in a degenerating tendon bed.

A majority of the reported cases occur in women who are usually in the middle-age group. In Axhausen's<sup>6</sup> series of ten cases, nine of the patients were women. In Honigmann's<sup>9</sup> series of twenty-four cases, sixteen of the patients were women. This higher incidence of the disease in women lends credence to the vascular etiology of the disease. The fact that the blood vessel structure in women is more frail and thus more susceptible to trauma than in the male is well known. Together with this, it has been shown that in approximately 5 to 8 per cent of cadavers there is a definite hypogenesis of blood vessels in the nature of smaller vessels and a decrease in their normal number of branches. Also Weigeldt<sup>10</sup> has shown that the vascular supply to the extensor pollicis longus tendon decreases after twenty-five years of age. Thus it can be readily seen that a Colles's fracture in

a female over twenty-five years of age who might possibly be in that group of individuals who have hypogenesis of their vascular system, might be readily followed by a delayed rupture of the extensor pollicis longus tendon. While these requirements may seem fairly rigid to apply to any clinical condition, the majority of reported cases of delayed rupture of the extensor pollicis longus tendon do occur in women in the middle-age group following trauma to the wrist, usually a Colles's fracture.

Of the two factors participating in the etiology of the disease, namely, the trauma to the tendon and the disturbance of its blood supply, it is impossible to give any accurate percentage as to which is the more important in any individual case. It would seem that both must be present to some degree. The fact that the rupture is so long delayed lends support to the fact that the interference to the blood supply is the basic etiological factor rather than the mechanical irritation.

Moore<sup>3</sup> has made an interesting observation in that in the three cases that he observed in 500 instances of Colles's fracture, all of them were treated with a non-padded plaster cast with immediate active motion as recommended by Bohler;<sup>11</sup> whereas out of the many hundreds of cases treated previously with immobilization for seven to ten days without Bohler's technic, no cases of rupture had ever occurred. This suggests that the use of a non-padded plaster cast together with the early active motion advised in Bohler's method of treatment might be a factor in aggravating the already existing tendon damage.

The treatment of the condition is surgical, the type of repair that is carried out being dictated by the condition of the tendon found at the time of operation. Simple suture is seldom advised inasmuch as the tendon must be replaced in an inflammatory bed and adhesions of the roughened surface of the tendon to the adjacent structures is inevitable. Repair has been carried out by means of tendon graft with moderate success. Best results

are obtained, in the opinion of Watson-Jones,<sup>12</sup> by using a transplant from either the extensor carpi radialis longus or brevis. This operation is reasonably simple, can be quickly carried out, gives a good functional result and involves only a minimum of muscular re-education.

#### SUMMARY

A case of delayed rupture of the extensor pollicis longus tendon following Colles's fracture is reported. The disease occurs roughly on an average of once in 250 cases, usually in women in the middle-aged group of from twenty-five to forty years. The greater incidence of the disease in women is explained on the basis that the blood vessel structure in women is more frail and thus more susceptible to trauma.

The cause of the rupture would seem to be dependent upon both trauma to the tendon and interference with its blood supply sustained at the time of fracture.

The use of an unpadded plaster cast together with early active motion, as advised in Bohler's technic, may possibly be a contributing etiological factor.

Good functional and anatomical results were obtained in the case reported by

operative repair, using a tendon transplant from the extensor carpi radialis longus.

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# MULTIPLE PRIMARY MALIGNANT NEOPLASMS OF THE RECTUM AND SIGMOID COLON

## REPORT OF FIVE ADDITIONAL CASES

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IN 1939, the authors<sup>1,2</sup> reported seven cases of multiple primary malignant tumors occurring in the rectum or sigmoid and other parts of the human organism, and three contact growths.

It is our purpose to present five additional cases that have been encountered on our service during the ensuing five-year period:

### CASE REPORTS

CASE I. R. F., a white female, aged fifty-two, was seen in consultation August 4, 1944. She stated that she had been bleeding for seven or eight years, but since May there occurred a change in the character of the blood. Previously the blood was bright red in color, sparse in amount and was noted on the stool or following an evacuation. On May 3, 1944, a hemorrhoidectomy had been performed, but shortly thereafter she experienced five or six evacuations daily. She had been constipated for many years and required laxatives. The stools were usually of the constipated type except when excess laxatives were resorted to. Recently the evacuations consisted of a "pinkish liquid" and "gas" which left her with a feeling of incompleteness and fullness. The first movement each day occurred when she first arose in the early morning, but frequently she had an incomplete evacuation during the night. During the day the patient usually passed a fairly well formed stool which was accompanied by bright red blood; the sense of fullness was relieved temporarily. No weight loss was cited. The patient had had a thyroidectomy fourteen years previously and recently had been hospitalized for hypertension. Her family history was irrelevant.

Proctoscopy revealed a cauliflower-like growth at a distance of 12 cm. involving the anterior and lateral phases of the rectosigmoid.

The process presented nodularity, ulceration and eversion of the edges. Biopsy made of the lesion was reported adenocarcinoma of the rectum grade III.

The patient was hospitalized August 9, 1944, and on the fifteenth a one-stage abdominoperineal proctosigmoidectomy without the establishment of an abdominal colostomy and with preservation of the sphincter muscles was performed. Approximately 40 cm. of rectum and sigmoid were resected. After completion of the operation the specimen was opened and it was found to contain an additional lesion. Description of the specimen was as follows: "Specimen of bowel measures 40 cm. in length; 15 cm. from distal end there is a large fungoid tumor mass which measures 6 cm. in diameter. It occupies the major portion of the wall circumference. The central portion is ulcerated and the base indurated. The tumor penetrates the entire thickness of the wall to invade the subserosal fat, but no enlarged nodes are palpated. Ten cm. above this lesion there is a papilloma measuring 1 cm. in diameter and 4 cm. in length. Sections taken from the large tumor mass show it to be adenocarcinoma. Sections taken from the distal end of the polypoid growth show it to be undergoing papillary proliferation with early malignant change. Diagnosis: Carcinoma of rectosigmoid and malignant papilloma of proximal sigmoid." The patient had an uneventful recovery and was discharged on the fifteenth postoperative day.

CASE II. A. T., a white male, aged sixty-seven, was referred because of abdominal pain and rectal bleeding. For a period of six months the patient had experienced pain in the lower abdomen which was partially relieved by defecation. An occasional pain was experienced in the rectum at the time of bowel movement. Three months previously the patient had passed considerable red blood with

each bowel movement. The patient stated that he had always been constipated. He had no early morning diarrhea; two stools daily were incomplete and unsatisfactory. A frequent desire for evacuation was cited; usually flatus and débris were expelled. He had lost approximately three to four pounds during his illness. The past history was irrelevant.

On digital examination a cauliflower-like mass presenting fixation, nodularity and eversion of the edges was noted. Proctosigmoidoscopy revealed a circumferential, crater-like process. Biopsy made was reported adenocarcinoma of the rectum grade III.

On June 15, 1943, a one-stage abdominoperineal proctosigmoidectomy without the establishment of an abdominal colostomy and with preservation of the sphincter muscles was performed. Fifteen cm. of the rectum and lower sigmoid colon were removed. The process penetrated the entire wall of the gut to cause puckering of the overlying serosa and there was enlargement of regional lymph nodes. No metastasis to the liver was demonstrable. The patient's postoperative course was uneventful and he was discharged from the hospital on his twelfth day. In March 1944, nine months following operation, his family physician discovered a small lesion on the right side of his tongue. A biopsy was made by a local surgeon and a diagnosis of epithelioma made. On May 5, 1944, the patient was operated upon for his second malignant lesion by Dr. J. Blady.

CASE III. Mrs. M. M., white, aged sixty-nine, was referred July 12, 1943, because of rectal bleeding. For a period of three weeks she had noticed bright red blood after each bowel movement. The blood was sparse in amount and there was no history of frequent stools or early morning diarrhea. The movements were complete and satisfactory, however, the patient experienced a sense of fullness in the lower part of the abdomen after each defecation. Her weight was seventy-two pounds.

Two years previously the patient had been operated upon for cancer of the right breast. There was no evidence of metastasis at this time. Her father died of cancer of the stomach.

On proctosigmoidoscopy a papillary adenocarcinoma was noted at a distance of 14 cm. The tumor was located in the left lateral quadrant and involved approximately one-quarter of the circumference of the rectum. A biopsy made at this time was sent to the

Temple University Hospital and reported as follows: "The sections show these fragments of tissue to consist of adenocarcinoma. The cells are of the tall cylindrical type which one expects to see in a primary carcinoma of the rectum. Diagnosis: Adenocarcinoma of the rectum."

The treatment in this case was determined by the patient's poor physical condition and refusal of the family for any surgical procedure. Electrofulguration was instituted July 19, 1943, through a sigmoidoscope and thereafter at weekly intervals. Some gain in weight was experienced and three months later there was clinically no evidence of malignancy. The patient returned for re-examination after a period of eight weeks and recurrence was noted. Again a palliative double-barreled colostomy with implantation of radon from above and from below was advised but refused.

CASE IV. Mrs. F. W. C., white, female, aged fifty, was seen in consultation October 29, 1943. The patient's symptoms began three months previously with a bearing-down sensation and a frequent desire for defecation. The bowel movements were incomplete and unsatisfactory. Often when the patient had the urge for a bowel movement only flatus and small amounts of fecal material mixed with blood would be expelled. The blood was sparse in amount, bright red in color and occurred only with evacuation. The patient was uncertain whether or not she had lost any weight. Past and family history were irrelevant.

Digital examination revealed thickening of the upper portion of the rectovaginal septum. Upon advancing the finger a large mass approximately the size of an orange was encountered. The mass was hard and circumferentially placed; it presented fixation, nodularity and eversion of its edges. Vaginal examination disclosed a serosanguineous discharge. A malignant type of erosion of the cervix was noted. The uterus itself did not seem to be fixed, but infiltration existed in the vault.

Biopsies of the cervical and rectal lesions were reported adenocarcinoma grade II of the rectum and squamous cell carcinoma grade III of the uterine cervix. On November 9, 1943, an abdominoperineal proctosigmoidectomy without the establishment of an abdominal colostomy and with preservation of the sphincter muscles was performed.

The report of the operative specimen examined and recorded by Dr. A. L. Pietrolongo

read as follows: "The specimen is a piece of bowel measuring approximately 18 cm. in length. In the central portion there is an ulcerative tumor mass which completely surrounds the lumen. The edges are raised, rolled and firm. The floor is deeply ulcerated with necrotic tissue. Examination of the subserosal fat fails to show any evidence of enlarged lymph nodes. The tumor apparently infiltrates the entire thickness of the bowel wall. Numerous anaplastic glandular structures are found diffusely infiltrating the wall. A chronic inflammatory reaction accompanies the process. Diagnosis: Adenocarcinoma of colon, grade II." The cervical lesion was treated with radium by Dr. W. Steel, the referring physician.

CASE V. Miss M. M., a white female, age thirty-eight, was operated upon for carcinoma of the cecum in October, 1941. The operation consisted of an ileocolostomy followed by resection. The growth removed by Dr. J. L. Summey was reported as adenocarcinoma. She was symptom free thereafter.

On December 20, 1944, she was referred to us with the diagnosis of carcinoma of the rectosigmoid junction. The history revealed that she began to pass mucus streaked with blood some eighteen months after her first operation. Later she experienced sharp pains in the left lower quadrant becoming more constant and relieved only by reclining. The stools were described as small and often black in color. The pain forced her to consult her physician who by double contrast enema found a space-taking lesion at the rectosigmoidal region. Further examination revealed a circumferential cancerous process, adenocarcinoma grade II.

The patient was admitted to our clinic and on December 27, 1944, was operated upon for her second primary malignancy. A sigmoidectomy was performed using the aseptic technic and a temporary transverse colostomy established proximal to the primary anastomosis. The left tube and ovary were enmeshed in the cancerous bowel and removed. There was no evidence of metastasis.

Gross description of the specimen was as follows: "The specimen is a segment of large bowel about 25 cm. in length to the serosal surface of which a tube and ovary are attached. In the center of the bowel a large ulcer 4 cm. in diameter is found on the mucosal surface. The ulcer base contains necrotic tissue. Its edges are firm but proliferative. The mucosal surface in the immediate vicinity has become

involved in the neoplastic process as is demonstrated by polypoid masses which are really part of the advancing tumor edges. The tumor has penetrated the entire thickness of the bowel and the tube and ovary are closely adherent at this point. Grossly no definite evidence of tumor penetration is seen. The ovary contains follicular and hemorrhagic

TABLE I  
DOUBLE MALIGNANCY IN THE ANUS, RECTUM  
AND SIGMOID COLON

Author	Site	Site
Graham (3).....	Rectum	Rectum
Krasko (4).....	Rectum	Anus
Bargen & Rankin (5).....	Rectum	Sigmoid
Morton (6).....	Rectum	Sigmoid
Bargen & Rankin (5).....	Sigmoid	Sigmoid
Bargen & Rankin (5).....	Rectum	Rectum
Bargen & Rankin (5).....	Rectum	Rectum
Bargen & Rankin (5).....	Rectum	Sigmoid
Bargen & Rankin (5).....	Rectum	Sigmoid
Hochenegg (7).....	Rectum	Rectum
Robson & Knaggs (8).....	Rectum	Rectum
Abel (9).....	Rectum	Pelvic colon
Abel (9).....	Rectum	Rectum
Lockhart-Mummery (10).....	Rectum	Sigmoid
Lockhart-Mummery (10).....	Rectum	Sigmoid
Norbury (11).....	Rectum	Rectum
Miller (12) (101).....	Sigmoid	Sigmoid
Morgan (13).....	Rectum	Sigmoid
Papin (14).....	Rectum	Rectum
Rotter (15).....	Rectum	Rectum
Rotter (15).....	Rectum	Rectum
Rotter (15).....	Rectum	Rectum
Rotter (15).....	Rectum	Rectum
Rotter (15).....	Rectum	Rectum
Graham (3).....	Recto- sigmoid	Sigmoid
Graham (3).....	Rectum	Recto- sigmoid
Cole (16).....	Rectum	Pelvic sigmoid
Kirshbaum & Shively (17).....	Rectum	Sigmoid
Kirshbaum & Shively (17).....	Rectum	Sigmoid
Schweiger & Bargen (18).....	Rectum	Sigmoid
Schweiger & Bargen (18).....	Rectum	Rectum
Schweiger & Bargen (18).....	Rectum	Recto- sigmoid
Schweiger & Bargen (18).....	Rectum	Sigmoid colon
Schweiger & Bargen (18).....	Rectum	Rectum
Schweiger & Bargen (18).....	Rectum	Rectum
Schweiger & Bargen (18).....	Rectum	Sigmoid
Schweiger & Bargen (18).....	Rectum	Sigmoid
Silvers (19).....	Sigmoid	Sigmoid
Bacon (1) (2).....	Rectum	Rectum
Bacon (1) (2).....	Rectum	Rectum

cysts. Diagnosis: Adenocarcinoma of sigmoid, grade II, with ovarian capsular invasion.”

The patient’s postoperative course was satisfactory. She will return to the hospital at the end of a six weeks period for closure of the transverse colostomy.

A review of the literature of proved cases is appended in Tables I to VI.

ble for its separate group of metastases. To this Mercanton<sup>88</sup> added the following qualification: “that if after removal of two carcinomas the patient remains free from the disease, the two growths must have been independent else there should have been other metastasis.” It is evident that in carcinomas arising from the intestinal

TABLE II  
THREE OR MORE MALIGNANT LESIONS

Author	Site	Site	Site	Site
Lane (20).....	Rectum	Sigmoid	Breast	
Norbury (11).....	Rectum	Sigmoid	Transverse colon	
Dowden (21).....	Rectum	Sigmoid	Small Intestine	
Maingot (22).....	Rectum	Sigmoid	Anus	
Bargen & Rankin (5).....	Three separate carcinomas of the rectum and sigmoid			
Bargen & Rankin (5).....	Rectosigmoid	Rectum	Rectum	
Schmidt (23).....	Rectum	Rectum	Sigmoid	
Angevine (24).....	Rectum	Rectum	Anus	
Zimmerman (25).....	Rectum	Sigmoid	Left Adrenal	
Doering (26).....	Rectum	Rectum	Hepatic Flexure	
Wulf (27).....	Rectum	Hepatic Flexure	Splenic Flexure	
Miller (12) (101).....	Rectum	Hepatic Flexure	Transverse colon	
Bunting (28).....	Sigmoid	Cecum	Ileum	
Gotting (29).....	Rectum	Stomach	Larynx	
v. Mielecki (30).....	Rectum	Stomach	Larynx	
Jentzer (31).....	Rectum	Stomach	Orbit	
Bargen & Rankin (5).....	Sigmoid	Ascending colon	Splenic Flexure	Uterus (sa.)
Lauds (32).....	Rectum	Esophagus	Bile duct	Tonsil
Goetze (33).....	Rectum	Stomach	Prostate	Colon
Bargen & Rankin (5).....	Sigmoid	Cecum	Transverse colon	Splenic flexure
Klingenstein (34).....	Sigmoid	Ascending colon	Transverse colon	Uterus
Schweiger & Bargen (18).....	Sigmoid	Sigmoid	Sigmoid	
Litchman (35).....	Rectum	Sigmoid	Cecum	
Whigham (36).....	Rectum	Cecum	Prostate	
Bargen, J. R. (37).....	Sigmoid	Descending colon	Cecum	
Mayo, C. W. (38).....	Rectosigmoid	Cccum	Descending colon	
Kretschmer (111).....	Sigmoid	Bladder	Prostate	
Smith (112).....	Sigmoid	Descending colon	Cecum	
Bacon (1) (2).....	Rectum	Rectum	Sigmoid	

The postulates laid down by Billroth,<sup>87</sup> which must be fulfilled before multiple carcinoma can be identified as independent lesions, are well known because they have been mentioned by virtually every writer on the subject, but here again they bear repetition: (1) The two growths should differ histologically which must be so pronounced as to exclude the possibility that they are of the same origin, but in different stages of development; (2) each growth must spring from its parent epithelium; and (3) each growth must be held responsi-

epithelium the first of these postulates cannot well be satisfied because as Thompson<sup>89</sup> has said, “since carcinomatous degeneration of multiple intestinal polypi is entirely likely, it seems that this postulate need not be fulfilled in identifying multiple independent carcinomas of the intestine.” As a matter of fact, Bunting<sup>28</sup> is of the opinion that these postulates were intended to apply only to malignant growths arising in different organs. It is admitted that the limitations of these criteria are too strict because a



falsely low incidence has resulted. What then are the criteria which one is to employ? The fundamental problem is "what constitutes multiple primary malignancy?" Tumors arising independently of ante-

malignant growth occurring independently in the same individual. For this there are excellent examples such as polyposis of the large bowel and stomach, lymphosarcoma and multiple myeloma. But it is said that

TABLE III  
DUAL MALIGNANCIES OF THE GASTROINTESTINAL TRACT

Author	Site	Site	Author	Site	Site
Junghanns (39).....	Rectum	Colon	Feilchenfeld (54).....	Rectum	Stomach
Kuster (40).....	Rectum	Colon	Hanlon (55).....	Rectum	Stomach
Lockhart-Mummery (10).....	Rectum	Colon	v. Hanseemann (56).....	Rectum	Stomach
Lockhart-Mummery (10).....	Rectum	Colon	Orr (51).....	Rectum	Stomach
Norbury (11).....	Rectum	Colon	Lockhart-Mummery (10).....	Rectum	Stomach
Warren & Gates (41).....	Rectum	Colon	Kroger (57).....	Rectum	Stomach
Norbury (11).....	Rectum	Transverse colon	Devic & Gallavardin (58).....	Rectum	Pylorus
Handford (42).....	Rectum	Splenic flexure	Robson & Knaggs (8).....	Rectum	Icjunum
Eliot (43).....	Sigmoid	Splenic flexure	Lockhart-Mummery (10).....	Rectum	Pylorus
Bargen & Rankin (5).....	Rectum	Cecum	de Vries (59).....	Rectum	Stomach
Bargen & Rankin (5).....	Sigmoid	Ascending colon	Dectz (60).....	Rectum	Gallbladder
Abel (9).....	Pelvic colon	Descending colon	Brandt & Jekabson (61).....	Rectum	Pancreas
Karsner & Clark (44).....	Sigmoid	Descending colon	Nicholls (62).....	Rectum	Pancreas
Behrend (45).....	Rectum	Ascending colon	Muller (63).....	Rectum	Pancreas
Lockhart-Mummery (10).....	Rectum	Transverse colon	Maingot (100).....	Sigmoid	Stomach
Littlewood (46).....	Rectum	Splenic flexure	Stalker, Phillips, Pemberton (64).....	Sigmoid	Cecum
Littlewood (46).....	Rectum	Ascending colon	Kirshbaum, Shively (17).....	Sigmoid	Stomach
Cokkins (47).....	Pelvic sigmoid	Transverse colon	Kirshbaum, Shively (17).....	Sigmoid	Stomach
Cokkins (47).....	Pelvic sigmoid	Descending colon	Schweiger & Bargen (18).....	Rectum	Colon
Cokkins (47).....	Recto-sigmoid	Transverse colon	Schweiger & Bargen (18).....	Sigmoid	Ascending colon
Goriainowa & Schabad (102).....	Sigmoid	Stomach	Schweiger & Bargen (18).....	Recto-sigmoid	Transverse colon
Hauser (49).....	Sigmoid	Stomach	Schweiger & Bargen (18).....	Sigmoid	Cecum
Pemberton & Waugh (50).....	Sigmoid	Stomach	Schweiger & Bargen (18).....	Rectum	Cecum
Hauser (49).....	Rectum	Stomach	Schweiger & Bargen (18).....	Recto-sigmoid	Cecum
Orr (51).....	Rectum	Stomach	Schweiger & Bargen (18).....	Rectum	Ascending colon
Rau (52).....	Rectum	Stomach	Schweiger & Bargen (18).....	Rectum	Cecum
Judd & Phillips (53).....	Rectum	Stomach	Saltzstein, Kelly (65).....	Recto-sigmoid	Transverse colon
			Hellendall (66).....	Sigmoid	Appendix
			Herrlin, Mersheimer (67).....	Sigmoid	Cecum
			Danes (103).....	Rectum	Pylorus
			Bull (110).....	Sigmoid	Stomach
			Bull (110).....	Sigmoid	Stomach
			Bacon (1) (2).....	Rectum	Stomach
			Bacon (1) (2).....	Rectum	Stomach

cedent tumor growth are known as primary tumors. Whereas a mutation for tumor usually occurs in a single group of cells—unicentric origin, it cannot be denied that it does occur occasionally in several groups of cells—multicentric or pluricentric origin. This is understood to mean more than one

multiple malignancy superimposed on an existent intestinal polyposis, while a distinct entity, is not considered in this discussion.

The question arises, should these growths be histologically distinct and heterogeneous? It is generally agreed that two tumors

which are distinctly different histologically are independent, but it does not necessarily follow that histologic similarity represents one parent tumor from which the other has sprung. We know that sarcoma and carcinoma or the mixed type of carcinoma sarcomatodes, early stressed by Virchow, does occur. Probably this is the result of some abnormal stimulus acting on the epithelial and mesodermal elements for which there is some evidence. The

TABLE IV  
MULTIPLE MALIGNANCY OF THE LOWER INTESTINAL TRACT AND GENITO-URINARY SYSTEM

Author	Site	Site
Bilz (68).....	Sigmoid	Uterus
Hanlon (55) .....	Sigmoid	Uterus
Lockhart-Mummery (69).....	Rectum	Uterus
Fried (70).....	Anus	Cervix
Warren & Gates (41).....	Rectum	Cervix
Warren & Gates (41).....	Rectum	Cervix
Hanlon (55).....	Rectum	Fallopian tube
Scharlieb (71).....	Rectum	Both ovaries
Goullioud (48).....	Sigmoid	Ovary
Rau (52).....	Rectum	Ovary
Tanberg (72).....	Rectum	Kidney
Hanlon (55).....	Rectum	Kidney
Hanlon (55).....	Sigmoid	Kidney
Bilz (68).....	Rectum	Kidney
Hanlon (55).....	Rectum	Kidney
Hanlon (55).....	Rectum	Kidney
Hanlon (55).....	Anus	Prostate
Junghanns (39).....	Rectum	Prostate
Muller (63).....	Sigmoid	Prostate
Hanlon (55).....	Rectum	Pcnis
Hanlon (55).....	Sigmoid	Penis
Nehrkom (73).....	Anus	Bladder
Stalker, Phillips, Pemberton (64).....	Sigmoid	Uterus
Kirshbaum, Shively (17).....	Rectum	Kidney

investigations of Ehrlich and Apolant<sup>90</sup> which resulted in the production of a typical sarcoma following the repeated inoculation of mice with a typical adenocarcinoma are worthy of mention, also those of Russel<sup>91</sup> who succeeded in obtaining a pure sarcoma after continuous growth of an adenocarcinoma of the breast in a mouse. These experiments were confirmed by Foulds.<sup>92</sup> Others have cited their investigations.<sup>105, 106, 107</sup> Haaland,<sup>93</sup> too, propa-

gated a slow-growing adenocarcinoma in a mouse which exhibited sarcomatous change. According to Major<sup>94</sup> this change is con-

TABLE V  
MISCELLANEOUS CASES

Author	Site	Site
Junghanns (39).....	Rectum	Esophagus
Bilello & Montanini (74).....	Rectum	Esophagus
Carnevale-Ricci (75).....	Rectum	Esophagus
Ophuls (76).....	Rectum	Esophagus
Rau (52).....	Rectum	Esophagus
Rau (52).....	Rectum	Esophagus
Rau (52).....	Rectum	Esophagus
Kaufmann (104).....	Rectum	Orbit
Hanlon (55).....	Sigmoid	Face
Klebs (77).....	Rectum	Eyelid
dc Besche (78).....	Rectum	Lip
Hanlon (55).....	Rectum	Lip
de Vries (59).....	Rectum	Tongue
Gottstein (79).....	Rectum	Tongue
Hellendall (65).....	Rectum	Breast
Eliot (43).....	Sigmoid	Breast
Lockhart-Mummery (69).....	Rectum	Breast
Norbury (11).....	Rectum	Breast
Norbury (11).....	Rectum	Breast
Kesteven (80).....	Rectum	Breast
Lockhart-Mummery (10).....	Anus	Breast
Eliot (43).....	Rectum	Breast
Hanlon (55).....	Rectum	Breast
Williams (81).....	Rectum	Breast
Seccof (82).....	Rectum	Lung
Lockhart-Mummery (10).....	Rectum	Bronchus
Muller (63).....	Rectum	Bronchus
v. Volkmann (83).....	Rectum	Skin of buttocks
Warren & Gates (41).....	Rectum	Skin
Hibshman (84).....	Rectum	Tongue
Stalker, Phillips, Pemberton (64).....	Sigmoid	Both breasts
Kirshbaum, Shively (17).....	Sigmoid	Tonsil
Kirshbaum, Shively (17).....	Rectum	Hepatic
Kirshbaum, Shively (17).....	Rectum	Gall bladder
Litchman (35).....	Rectum	Lung
Bacon (1).....	Sigmoid	Lip
Bacon (1).....	Sigmoid	Esophagus
Bacon (1).....	Rectum	Nose
Bacon (1).....	Rectum	Tongue
Bacon (1).....	Rectum	Gall bladder

trolled almost entirely by the time element, inasmuch as where the transplanted carcinoma is removed early and transmitted to another animal of the same species, carcinoma results; but if the transplanted carcinoma is permitted to grow until it becomes sarcoma, then all animals injected

develop a pure sarcoma. One may recall the case cited by Kidner<sup>95</sup> in which a carcinoma developed in the operative scar after removal of a sarcoma.

There has been much discussion as to whether one malignant growth has an inhibitory influence on the development of another primary neoplasm in the same individual. According to Lockhart-Mummery<sup>10</sup> there seems to be sufficient clinical evidence to show that one malignant growth does inhibit such development and Dukes<sup>96</sup> has cited some interesting experiments in

reason why more than one glandular organ should not be exposed to the exciting cause of carcinoma, whatever that may be, either at about the same time or many years later." So far as metastases are concerned all would tend to produce those of the same type but in different locations. The opinion is fairly universal that taking all phases into consideration, the various factors point to some general change as the predisposing cause of multiplicity. Slaughter<sup>98</sup> in a recent article expresses the opinion that the etiologic factor of malig-

TABLE VI  
SARCOMA AND CARCINOMA IN DIFFERENT SYSTEMS

Author			
Warren & Gates (41).....	Adenocarcinoma, rectum	Lymphosarcoma, rectum	Osteoma, jaw
Landau (99).....	Carcinoma, rectum	Fibrosarcoma, breast	
Werner (85).....	Adenocarcinoma, rectum	Fibromyosarcoma, uterus	
Nehrkorn (73).....	Melanotic sarcoma, rectum	Carcinoma, uterus	
Dijkstra (86).....	Spindle cell sarcoma, rectum	Carcinoma, gallbladder	
Bergen & Rankin (5)..... (cited also in Table I).....	Adenocarcinoma, sigmoid	Sarcoma, uterus	

animals in an attempt to prove that transplantation of a part of the original malignant tumor to healthy tissue elsewhere in the body, tends to cause disappearance of the primary neoplasm. Others are equally firm in their belief that immunity is not conferred, or that one primary malignant growth does not inhibit the development of another.

As to the occurrence of these growths, statistics show that they are more common in organs unrelated by any system. By means of breeding experiments on mice, Maud Slye<sup>97</sup> has shown that spontaneous cancer is inherited as a Mendelian dominant. Indeed, her work is impressive in that there is probably a susceptibility to tumor formation in individuals developing multiple malignant growths and because these are not limited to any organ or portion of the human body. There seems to be little significance as to the distinction between synchronous and metachronous growths. As Eliot<sup>43</sup> has said "there is no

nancy acts on all tissues of one type and may produce multiple lesions. Multiple tumors occurring in different organs suggest a tumor diathesis inasmuch as they occur more frequently than could be expected on the basis of chance alone.

Secondary tumor formation was accredited to the existence of a continuous network in the submucosa of the bowel, but this since has been disproved. The occasional transmission of cancer by retrograde venous embolism has been cited also. Even though they may appear similar, secondary growths should not be confused with multiple primary malignancy.

It is recognized that an implantation type of cancer does exist, many authentic cases of which have been reported.<sup>22, 106, 108, 109</sup> Such may occur from one labia to the other or from one side of the anus to the other as recently encountered by the writers. Growths limited to a small portion of the bowel such as the sigmoid or rectum may occur by direct contact, a detached

fragment of the primary lesion being engrafted onto another portion of the mucous membrane. In such, a marked variation in the histologic appearance would not be expected inasmuch as they arise from the same type of epithelium. It is obviously difficult to determine their exact status. Where the aboral growth is the younger or where the two tumors are situated out of contact with each other or possibly when a prolonged period of time separates the appearance of the two neoplasms, they must be considered both primary neoplasms.

In order to obviate a falsely low incidence of multiple primary malignancy, there has been a tendency to liberalize the original requirements. Those suggested by Warren and Gates seem logical and are here cited, "each of the tumors must present a definite picture of malignancy; each must be distinct, and the possibility of one being a metastasis of the other must be excluded." In other words as Cokkins<sup>47</sup> has said a good rule to follow is that if two malignant tumors co-exist, or follow each other, and it can be definitely established that one is not a metastasis of the other, they must be regarded as primary growths.

#### SUMMARY \*

The literature on the occurrence of multiple primary malignancies has been reviewed. An effort has been made to bring to date the total of such cases in which one or more lesions were located in the anus, rectum, or sigmoid colon. Additional cases have been presented in which there would seem to be no doubt of their multicentric origin.

The conclusion is reached that (1) although it is by no means easy to establish evidence of multicentric origin in all cases of multiple malignancy, several cases are found and reported each year. (2) The rate of reported cases is 8.8 per year when the cases are limited to the involvement of anus, rectum and sigmoid colon. (3) It is evident that one malignancy does not confer immunity against another. (4) The

possibility of multiple neoplasms should be kept in mind.

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# TRAUMATIC INFARCTION OF THE KIDNEY

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A RECENT review of the literature<sup>1</sup> stated that while renal infarction itself is not unusual, it occurs rarely as a direct result of trauma. Hirschberg and Soll<sup>1</sup> report one case in a forty-eight year old man as a result of an auto accident. The patient was operated upon, a nephrectomy performed and the patient recovered. In a survey of 376 cases of renal infarction reported, only two additional cases were due to trauma. One of these was reported in a review by Aschner as being discovered at the autopsy of an eight year old boy who had a severe fall eight days previously. The other was from the autopsy records of the Massachusetts General Hospital, of a man who also died eight days after a fall on his back.

The clinical picture as reported in these cases, closely resembled or was indistinguishable from that of a ruptured kidney. The usual diagnostic aids are equivocal. The history of trauma and the absence of cardiac disease (the greatest single cause of renal infarction) in the presence of abnormal kidney function, local tenderness, fever, and sometimes a hematuria, all may suggest infarction. Intravenous pyelograms are a valuable procedure in some cases and should be done early in all cases. However, as Sargent<sup>2</sup> has pointed out, if the injury is serious the patient is often in shock and even if the kidneys are not damaged they cannot be expected to excrete the dye in sufficient concentration to form good detail in the pyelograms. If the kidney is damaged, blood clots may fill the pelvis and ureter to such an extent as to displace the dye. Ileus, which is common in this condition and practically all retroperitoneal hematomas and irritations, may further

obscure the detail of the films and often suggests intestinal obstruction.

We do not agree with Sargent that retrograde pyelograms must be made in all accident cases in which injury to the kidney is suspected. We do believe that it should be done if the intravenous pyelograms and the clinical picture are not satisfactory in every detail. The dangers of the retrograde procedure, which have been listed<sup>1</sup> as secondary hemorrhage, infection and embolism, are not as great as they were formerly thought to be and the information to be gained is tremendous. Damage to the pelvis or the kidney itself will usually be well visualized and this in turn will facilitate the decision as to the course of treatment, whether conservative or operative.

## CASE REPORT

We wish to present the case of J. W., a white male, aged twenty-seven, who on September 11, 1942, was working on the side of a building when a passing crane squeezed him against that building and scraped him along the wall for a distance of six feet. He was not rendered unconscious but suffered exquisite generalized pain. An ambulance brought him immediately to Harper Hospital where he was admitted to the x-ray department. Films were made of the dorsolumbosacral spine, the pelvis and the thoracic cage. There was no demonstrable fracture. This surprised us, in view of the acutely ill appearance of the patient.

He continued to complain of pain all over his body, but particularly about his thorax, upper abdomen and shoulders. The past history was negative other than for spells of what might have been attacks of *petite mal* and a head injury suffered three years before.

Physical examination revealed a well developed and well nourished white male acutely ill and appearing to have severe pain. The head

and neck were normal. The thorax showed many abrasions, both anteriorly and posteriorly. The costal margins moved freely and

count on admittance was: hemoglobin 87 per cent, red blood cells 4.44, white blood cells 23,250, stab. 16, segm. 75, L. 3, M. 5, red blood



FIG. 1. Left retrograde pyelogram made on September 15, 1942, showing normal shadows.



FIG. 2. Posterior view of the left kidney after operation showing mottled color but no signs of rupture.

equally although the excursions were somewhat limited by pain, which was generalized over the clavicles and ribs. Heart and lungs were normal. Blood pressure was 130/80; pulse 72 and strong. In the abdomen there was exquisite tenderness in the mid-epigastrium and in the left upper two-thirds of the abdomen. There was some splinting of the left side of the abdomen but it was uncertain as to whether or not this was voluntary. There was a well healed McBurney's scar. There were abrasions over the low back and the lateral portions of the left thigh and leg.

The patient had boards placed under his mattress and was watched closely. The blood pressure remained the same until the following day when it became 140/88. A urine sample was examined immediately upon the patient's entrance to the hospital and this showed no blood but a trace of albumin. A second specimen showed a few red cells but repeated examinations in the next few days did not confirm this finding, although the albumin increased from a trace to ++ two days later. The blood

cell was normal in shape and size. Report in two hours: hemoglobin 90 per cent, red blood count 4.84, white blood count 17,350, indication no severe bleeding or loss of serum. Kahn was negative. In five days the hemoglobin dropped to 71 per cent, the red blood count remaining about the same, as did the leukocytosis, although the differential count shifted to Stab. 69, segm. 15, L. 7, M. 7.

The patient was put on a fluid diet but the evening of admission his temperature went to 99.6°F. and he began to vomit. He then began a daily temperature elevation to 101°F.

The day after admission a flat plate of the abdomen was made and compared with the examination done on the day previous. This revealed diminution in the usual gas shadows of the left abdomen, particularly in the left upper quadrant. However, it was impossible to state that this could be considered as definite evidence of retroperitoneal or intra-abdominal collection of fluid or hemorrhage. The



psoas shadow on the left was definitely less distinct than that on the right and the outline of the soft tissue structures in the left upper

a week, during which time the patient began to take fluids well and had much less pain. Cystoscopy was then repeated on September



FIG. 3. Both sides of bisected left kidney showing three darkened areas of infarction.

quadrant was not as definite as normally expected.

The patient continued to have thoracic and epigastric pain as well as nausea and vomiting. Sedation and fluids were given and x-rays repeated on the third consecutive day, this time including the chest, without getting new information. The urinary output remained low. On September 14th, intravenous pyelograms were made. The right side was entirely normal but the dye was not excreted by the left kidney. The next day the patient was cystoscoped and the left ureter catheterized. No urine was obtained and the return flow of injected water was reddish in color. Intravenous indigo carmine appeared on the right side in six minutes but in ten minutes there was none from the left side. Retrograde pyelograms were made, showing a normal pyelogram but the kidney outline was not differentiated from the surrounding tissue structures.

Conservative treatment was maintained for

22nd. This time the left ureter was watched for thirty-five minutes for signs of indigo carmine without it appearing, although it appeared on the right side in seven minutes.

With the preoperative diagnosis of damaged kidney, nephrectomy was undertaken under intratracheal ether anesthesia on September 26th. The kidney was very adherent to the perirenal tissue. In freeing the upper pole of the kidney a large pararenal cavity was opened. This contained watery gray fluid. The cavity extended up along the pedicle and crossed the great vessels and up to the neighborhood of the diaphragm. The kidney was freed and delivered, the pedicle clamped and double ligated, the vessels ligated in front of the clamps, the ureter ligated and the kidney removed. Rubber tissue drains were inserted up into the large cavity and a large gauze drain in the region of the pedicle. The wound was closed in layers after being dusted with sulfathiazole powder.

The kidney was 12 by 5 by 4 cm. with thickened mottled brownish yellow-gray capsule and had a red smooth external surface. Section revealed three yellowish gray irregularly triangular areas which were soft infarcts, the largest being in the form of a 3 cm. equilateral triangle. Over 50 per cent of the renal tissue had been destroyed. The remaining portion had poor cortical and medullary demarcation. The microscopic examination showed massive infarction and necrosis of renal tissue.

Immediately postoperatively the patient was given 500 cc. of blood and in six days the temperature was normal. The drains were removed on the seventh day and the skin stitches on the eighth postoperative day. Drainage at first was copious and watery and was irritating to the skin. It was decided that the watery fluid in the cavity surrounding the kidney at the time of its removal represented a pancreatitis caused by the trauma. The blood amylase was elevated to 549 mg./100 cc. on October 10th. In five days this had fallen to 150 mg./100 cc. In a week the drainage became purulent but the temperature remained normal until the twelfth postoperative day. At that time medical consultation, confirmed by x-rays, revealed a pneumonic process in the left lower lobe. This responded very well to sulfathiazole.

Drainage persisted and on October 29th the sinus tract was injected with lipiodal and

a very extensive sinus tract leading to the kidney bed was revealed in the x-ray and was still present in another x-ray on November 23rd. On December 5th the wound was incised, the sinus tract enlarged and curetted and sulfanilamide powder placed in the wound. Deep x-ray therapy was given over this area on December 15th and 21st. There was still a fair amount of watery discharge.

The patient was discharged from the hospital January 20, 1943.

#### SUMMARY

1. A case of traumatic infarction of the kidney, the fourth to be reported, is presented.

2. Differential diagnosis is difficult in these cases.

3. Intravenous pyelograms should be made early and if unsatisfactory in any detail then retrograde studies are indicated.

4. The dangers of retrograde pyelography are far outweighed by the information that they give.

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# SALIVARY CALCULI

## CASE REPORT

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**C**ALCULI may develop in the salivary glands and ducts as well as in other systems of the body as the urinary and biliary systems. The occurrence of salivary calculi, however, is much less frequent than that of urinary or biliary stones, but the clinical course of salivary calculi is roughly comparable to that of calculi in these other systems. The usual clinical sequence is pain or colic, obstruction, and then suppuration due to stasis.

### CASE REPORT

The patient, a white male, married, aged forty-seven; was admitted to Watts Hospital on January 5, 1943, on the surgical service of Dr. N. D. Bitting. He first began to have pain in the right submaxillary region about ten years ago. This pain was present only during meals, however, sometimes the pain was present when he merely smelled food. At that time he also noticed a small nodule about 1 cm. in diameter which appeared in the right submaxillary region during meals or when he smelled food and then disappeared again between meals.

He passed a small calculus through the right submaxillary duct a few weeks after the pain first began in this region. He first felt the stone with his tongue beneath the mucous membrane of the floor of the mouth and a few days later he passed the calculus. Since then he passed two other stones. Occasionally, he got a thick, stringy substance in his mouth which had the appearance of pus. No bleeding was present.

The pain and swelling in the right submaxillary gland continued intermittently until about three weeks before he entered the hospital when the pain began to be continuous and more severe. The swelling began to increase in size and did not disappear or diminish between attacks as it did before. At that time the

swelling also became moderately tender while previously it was not tender.

There was no trauma to his right submaxillary region at any time. He did not have any chills, but felt as if he had a fever the day before he entered the hospital. The only treatment he had prior to entry into the hospital was the passage of a sound or catheter into the duct. This failed to relieve the obstruction or improve the condition.

There were no abnormal findings on examination except in the right submaxillary region there was a firm hard tumor about 5 cm. in diameter situated at the angle of the mandible. This tumor was freely movable on the deep structures and was not adherent to the overlying skin. It was moderately tender on palpation. His temperature was 100.4°F., pulse 82, and respirations were 20. The systolic blood pressure was 140 and the diastolic was 70.

The red blood count was 5,000,000, the hemoglobin was 97 per cent, and the white blood count was 13,200 with 85 per cent neutrophils. Examination of the urine showed no abnormal findings except a small trace of albumin. The Wassermann and Kahn tests of the blood gave a negative reaction.

A rather large irregular calculus just anterior to the angle of the mandible was visualized on the roentgenogram. It appeared to be located in the submaxillary gland or in the posterior part of Wharton's duct. (Fig. 1.)

The diagnosis of a calculus in the right submaxillary duct with the presence of a pyogenic infection of the submaxillary gland was made, and on January 7th, the right submaxillary gland was removed by Dr. N. D. Bitting under a general anesthetic. The submaxillary gland with its capsule intact was excised and the wound drained with a small Penrose drain. On section of the gland a large amount of thick, whitish material which resembled pus escaped from the gland, and one large and a

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number of smaller calculi were found in the substance of the gland. (Figs. 2 and 3.)

The histological examination showed the

Salivary calculi usually occur in adult life and are more common in males than females about 2:1. The submaxillary



FIG. 1. Roentgenogram showing an irregular shadow of the calculi in the right submaxillary gland.

presence of a suppurative sialadenitis. There were only small remnants of glandular tissue left while numerous small ducts were surrounded by large numbers of lymphocytes. There was an increased amount of fibrous tissue present.

His postoperative course in the hospital was smooth. The highest temperature he had following operation was 100°F. He was discharged from the hospital on January 18th, eleven days following operation with complete healing of the wound.

The etiology of salivary calculi is not clear. Inflammation no doubt plays an important part. The deposition of calcium salts being initiated by a bacterial nucleus or by inflammatory epithelial debris. A few cases were reported in which a foreign body formed the nucleus upon which calcium salts were deposited. Pilcher reported a case in which a calculus formed around a piece of grass which was lodged in the duct. Many authors consider actinomyces as an etiological factor in the formation of salivary calculi.

gland is much more frequently involved than the others. In 174 cases reviewed from the literature the incidence of occurrence in either gland or duct were as follows: submaxillary 150 cases or 86.2 per cent, parotid twenty cases or 11.5 per cent, and sublingual four cases or 2.3 per cent.

The symptoms of salivary calculi are rather typical with intermittent pain and swelling in the region of the involved gland. The pain and swelling usually occur during meals or by the mere sight of food. The condition is usually chronic but may have acute exacerbations accompanied with cellulitis and fever. Pus may escape from the orifice of the duct. A moderate leukocytosis with an increase in polymorphonuclear leukocytes is frequently present. By a combined intraoral and extraoral palpation the hard stone can usually be felt. The orifice of the duct may be inflamed and pus can usually be expressed from it.

The roentgenogram is very useful in the diagnosis and should be done in every

case for occasionally there are multiple stones present. However not all stones can be demonstrated by x-ray, but about

has subsided. The passage of a catheter or sound should be avoided during this stage.



FIG. 2. Section of the submaxillary gland shows a large stone near the beginning of Wharton's duct and a number of smaller ones embedded in the substance of the gland.



FIG. 3. Calculi removed from the submaxillary gland.

80 per cent can be visualized. Iglauer stated that by depression of the floor of the mouth with the finger the submaxillary gland and duct could be depressed below the level of the mandible and then be visualized by a lateral x-ray. In cases in which a calculus was suspected in the anterior two-thirds of the submaxillary duct Ivy and Curtis suggested that an x-ray film be placed in the mouth between the upper and lower teeth and held in place by approximating the teeth. The film is placed as far back as possible and the rays directed upward from below the chin.

The treatment depends to a large extent upon the amount of infection and destruction of the salivary gland involved. In the presence of an acute inflammation it is advisable to treat the condition conservatively with hot compresses and hot irrigations until the acute inflammation

If the calculus is located in the submaxillary duct, it may be removed by an incision directly over the stone in the mucous membrane of the floor of the mouth. If a stone is situated in the gland proper, it is best to remove the whole gland through an inframandibular incision. Removal of the entire gland is usually necessary to clear up the condition and to prevent a recurrence in case of a calculus of long standing with the presence of chronic suppuration. It is apparent in the case reported here with the extensive suppuration and destruction present and also the presence of a few smaller stones in the substance of the gland that simple removal of the large stone would not have cleared up the symptoms in this case. New and Harper reported a recurrence of symptoms in 16.3 per cent of the cases in which a stone was removed through the mouth from the duct or gland without removal of the gland.

Stones in the sublingual gland or duct may be removed by an incision directly over the stone and is not a difficult procedure. When the stone is embedded in the substance of the gland, removal of the whole gland may be necessary.

Harrison advises the removal of salivary calculi whether they produce symptoms

or not for they are a potential danger and may cause serious trouble later.

up the symptoms and to prevent a recurrence of the condition.

#### SUMMARY

The case history of a man forty-nine years old who had symptoms of a submaxillary salivary calculus for ten years is reported. Removal of the calculus with the whole salivary gland gave him complete relief of the symptoms with no recurrence.

A calculus in the submaxillary gland or duct of long standing usually requires complete extirpation of the gland to clear

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THE chief indication for operation upon the parathyroid bodies is hyperparathyroidism. Transplantation of a parathyroid may rarely be indicated when it is removed by accident during thyroidectomy.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# RUPTURED ANASTOMOTIC ANEURYSM OF GASTRIC ARTERIES\*

## CASE REPORT AND REVIEW OF LITERATURE

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**R**UPTURED aneurysms of visceral vessels present an important differential possibility when the diagnosis of intra-abdominal hemorrhage is in question. This hemorrhage may occur either into a viscus, or more commonly, intraperitoneally.

In a fairly complete survey of the literature I have been unable to find any description of a case similar to the one herein reported. The most commonly involved visceral vessels are the splenic and renal arteries. According to Rosenthal's<sup>1</sup> review there are sixty-nine cases of aneurysm of the hepatic artery and five cases of aneurysm of the cystic artery in the literature. Laipply<sup>2</sup> was able to find thirty-three acceptable cases of aneurysm of the celiac artery. Kimpton and Dalrymple<sup>3</sup> reported a small submucosal aneurysm, in a branch of the superior mesenteric artery, which was resected surgically. Segall<sup>4</sup> encountered an asymptomatic pea-sized aneurysm of the gastroduodenal artery.

Bianchedi<sup>5</sup> in a complete review of the European literature on aneurysms of the gastric arteries found that the cases could be divided into four general groups: The largest group included eleven cases in each of which there was rupture of an artery in an area of atheromatous widening. Most of these were very small and several had ruptured into the stomach causing recurrent hematemesis. The second group was made up of congenital aneurysms and included Scheidegger's and Hirschfeld's cases in which an arterial aneurysm was found associated with marked varicosities of the gastric veins. In this group he also placed Delore, Comte and Labry's case of general-

ized ectasia of all the gastric vessels causing the entire stomach to pulsate in a remarkable manner. The third group included only a single questionable case of traumatic aneurysm. In the last group there were three cases of tiny, submucosal, bleeding aneurysms occurring in association with atrophic gastritis in chronic alcoholics.

Hoelzer<sup>6</sup> and Loeper and Lemaire<sup>7</sup> reported two instances of pin-head sized aneurysms being found in the centers of gastric ulcers. They suggested that the ulcers were secondary to repeated hemorrhages from the aneurysms. Suloff's<sup>8</sup> report was based on clinical data and is inconclusive. Levy<sup>9</sup> reported a case of multiple, large, arteriosclerotic aneurysms of the splenic, renal, gastric, and superior mesenteric arteries. The gastric aneurysm was 5 cm. in diameter and near the celiac axis.

### CASE REPORT

The patient was a fifty year old, white engineer who had been on the Isthmus of Panama for two and one-half months. Except for the fact that he had had typhoid fever in 1905, the family history and past history were not significant.

On September 18, 1942, while working in a jungle outpost, he developed a headache and was found to have a temperature of 102°F. He took several capsules containing codeine, aspirin, and phenacetin and because the symptoms persisted was admitted to Gorgas Hospital on September 22, 1942. He had developed anorexia on the day of admission but had no other gastrointestinal symptoms.

Physical examination on admission was essentially negative except for a temperature of 103.2°F. His blood pressure was 138 mm. of

\* From the Board of Health Laboratory, Gorgas Hospital, Ancon, Canal Zone.

mercury systolic and 80 mm. diastolic. Examination of the blood showed: hemoglobin, 75 per cent (Tallqvist); erythrocytes, 4,350,000 per cu. mm.; leucocytes, 13,400 per cu. mm.;

into shock for the third time. He failed to respond to the usual therapeutic measures, and died thirty minutes later in profound circulatory collapse.

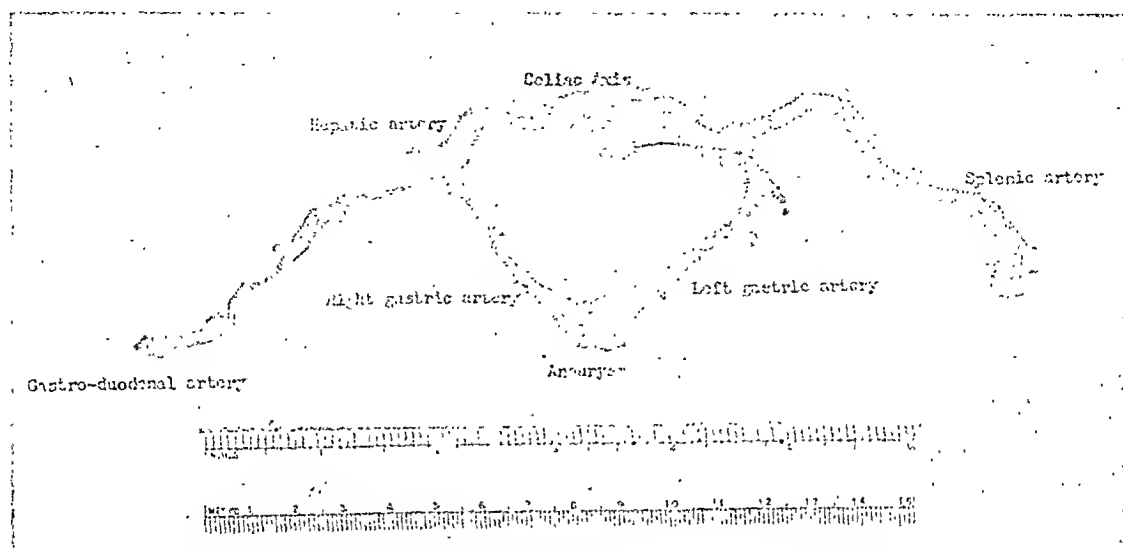


FIG. 1. Photograph of gastric aneurysm and branches of celiac axis dissected free from adjacent visceral structures.

with 81 per cent neutrophils and 19 per cent lymphocytes. In spite of a negative blood smear for malaria and the leucocytosis, a tentative diagnosis of malaria was made and 30 gr. of quinine were given orally. The patient vomited once. On two occasions during the next day the patient suddenly went into shock; he showed pallor and cold perspiration and his blood pressure fell to 80 mm. of mercury systolic and 50 mm. diastolic. Each time he responded promptly to stimulants and intravenous fluids. He had also episodes of dramatic, severe, painful, spasm of the epigastric muscles on exertion or when palpation was attempted. There was slight tenderness in the epigastrium, nausea, and rectal urgency. No fluid wave could be elicited and between the spastic attacks the abdomen was soft. An electrocardiogram was reported negative except for slight right axis deviation and sinus tachycardia; x-ray examination of the chest was negative.

On September 23, 1942, the erythrocyte count was 4,020,000 per cu. mm.; the leucocyte count was 11,300 and 8,200 per cu. mm. with the neutrophils increasing to 89 per cent. Malaria smears continued to be negative and the blood Kahn test was negative. Approximately thirty hours after admission he went

The body was embalmed immediately after death and a complete autopsy was performed sixteen hours later. Except for slight splenomegaly, dependent pulmonary congestion, an adenoma of the thyroid, and three pigmented nevi of the face, the significant gross and microscopic pathological changes were limited to the stomach and peritoneal cavity.

Gross description: The peritoneal cavity was filled with 2,200 cc. of free and clotted blood. Along the lesser curvature of the stomach there was a diffuse area of subserosal ecchymosis measuring 10.0 by 9.5 cm. Within this area and approximately 4 cm. proximal to the pylorus there was a firm, dark hematoma which measured 4.5 by 3.5 by 2.0 cm. Projecting through the tears in the serosa of the stomach, both above and below the gastrohepatic ligament, were three large and several small tongues of blood clot which measured as much as 1.3 cm. in thickness. The stomach and duodenum contained a small amount of gas and greenish fluid but no blood. The mucosa was smooth and normal in appearance. The gastric arteries arose from the usual sites and appeared to be of average size. No evidence of arteriosclerosis or occlusion was found. The right and left gastric arteries entered the hematoma 2.5 and 6.3 cm., respectively, from



the pylorus. In the center of the hematoma they united in a shamrock-shaped aneurysmal dilatation. The vessels entered at the ends of the ovoid base of the aneurysm which measured 1.5 by 0.7 cm. Ballooning out from the mucosal face of this aneurysm was a bulbous, pea-sized pouch which measured 0.8 by 0.7 cm. The wall of the aneurysm was very thin and it contained hard, black, blood clot. X-rays showed no calcification. A probe was passed through a narrow free channel through the ovoid portion of the aneurysm. At the pyloric end of the aneurysm, in the fold between the bulbous and ovoid portions, was a ragged, irregular tear measuring 0.6 cm. in length. The rest of the gastrointestinal tract was normal.

Microscopic description: The wall of the gastric aneurysm was very thin, being composed of only a few layers of smooth muscle fibers. In some places clusters of erythrocytes had extended between muscle layers causing them to undergo partial disintegration. No evidence of sclerosis or inflammatory reaction was seen in the wall of the aneurysm or adjacent blood vessels. The lumen of the aneurysm was partially filled with a dense blood clot showing cellular disintegration, laking, and leukocytic infiltration. A few slender strands of connective tissue extended through this blood clot. The patent channel comprised about one-fourth of the lumen of the aneurysm and contained well preserved blood cells. No endothelial lining or evidence of canalization could be discerned. In the hematoma immediately around the aneurysm there were many foci of intense polymorphonuclear infiltration and moderate fibroblastic activity, while peripherally in the hematoma the erythrocytes were well preserved and there was no evidence of inflammatory reaction or organization. Obviously the aneurysm had been leaking into the subserosa for some time prior to its

final complete rupture. The hemorrhage extended into the muscular layers of the gastric wall but the submucosa and mucosa were entirely normal. The serosa over the hematoma was thin and hyalinized.

#### SUMMARY

An anastomotic aneurysm of the right and left gastric arteries which ruptured causing profuse intraperitoneal hemorrhage has been described. No reports of similar cases have been found.

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# HYPERTROPHIC GASTRITIS SIMULATING CARCINOMA\*

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THE fact that chronic hypertrophic gastritis may occur in a form which is clinically indistinguishable from While the importance of syphilitic gastritis in producing prepyloric and antral stenosis is well recognized,<sup>10</sup> little emphasis



FIG. 1. X-ray taken on admission November 11, 1943, showing the cylindrical stenosis of prepyloric segment with incomplete obstruction.

carcinoma was first reported by Brunn and Pearl in 1926.<sup>1</sup> Since then similar cases have been described by Schindler,<sup>2,3</sup> Brunn and Gold,<sup>4</sup> Vass and Sirca,<sup>5</sup> Freeman, et al.<sup>6</sup> and others.<sup>7,8,9</sup> These reports were about equally divided between the polypoid form of gastritis and the stenosing hypertrophic variety.

has been given to the non-specific form of hypertrophic gastritis which may produce a similar lesion.

Ruffin, et al.<sup>11</sup> estimates that gastritis unassociated with ulcer is found by gastroscopy in 3 per cent of the general population; 50 per cent of this number is of the hypertrophic form, which gives an inci-

\* From The Migratory Labor Hospital, Belle Glade, Florida.

dence of 1.5 per cent for this type lesion. A similar incidence is quoted by Schindler<sup>12</sup> and Carey.<sup>13</sup> X-ray findings, laboratory

Since biopsy is not possible through a gastroscope all such cases must be explored surgically. Some workers<sup>4</sup> have advised



FIG. 2. Film taken after three and one-half weeks' conservative therapy showing little change in the funnel-shaped deformity.



FIG. 3. Film taken ten days after Hofmeister resection. Arrow indicates the anastomosis; about one-fifth of the stomach remains.

findings, and clinical symptomatology are unreliable in this disease. Clinically the diagnosis can only be made with certainty by gastroscopy.<sup>14-17</sup>

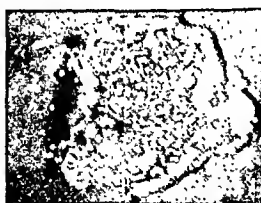


FIG. 4. Gross specimen reveals mucosal pattern completely replaced by nodular granulations; the pyloric mucosa was fairly normal.

Even after gastroscopic examination and complete x-ray studies there are a number of cases in which final judgment between carcinoma and gastritis is still doubtful.

biopsy of the lesion with delay of the resection, since frozen sections are usually unsatisfactory. Konjetzny and Floercken have advocated resection, since this procedure not only makes a positive diagnosis but effects a cure as well.<sup>18</sup> Schindler recommends resection for isolated polypoid gastritis of the antrum which he believes is a precancerous lesion.<sup>18</sup> At the present time there is a great difference of opinion as to the significance of gastritis as a precursor of cancer. The polypoid form is probably the most dangerous type from this standpoint.

Gastric resection may well come to be the treatment of choice for a number of these cases. Swalm, et al.<sup>15</sup> have followed by periodic gastroscopy the course of a large group of cases receiving various forms of treatment. Their conclusion is that neither the hypertrophic nor atrophic

form of gastritis is amenable to any known type of conservative therapy.

At the present time resection should be

of the time it occurred from ten to thirty minutes after his meals. During the past month he had vomited even after drinking

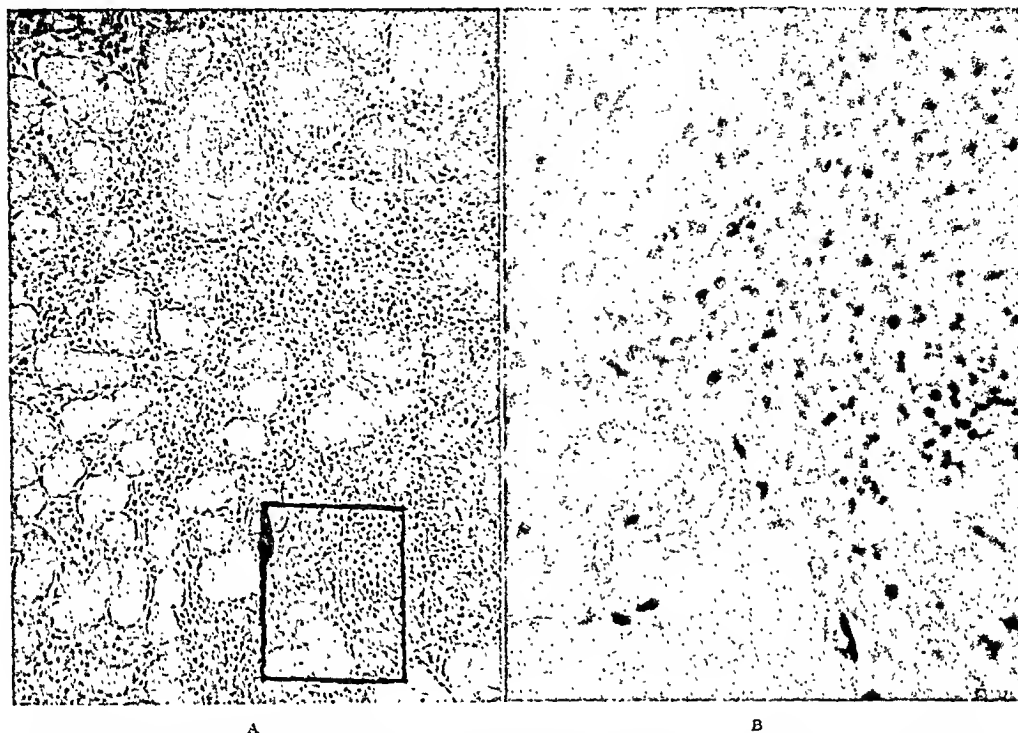


FIG. 5. A, section shows dense infiltration of mucosal layer with inflammatory cells. Insert shown in Fig. 5A. B, an enlargement of the outlined square in Fig. 5A shows the cells to be neutrophils, plasma cells, and lymphocytes.

considered only where there exists one of the following: (1) any doubt of the presence of carcinoma; (2) obstruction; and (3) localized polypoid gastritis which is considered to be precancerous.

In the case presented below a diagnosis of probable carcinoma and possible syphilis was made after a thorough clinical, laboratory, and x-ray study. At the time of operation no more definite diagnosis could be made. The pathologist's report was hypertrophic gastritis.

#### CASE REPORT

A negro male, age forty-six years, was admitted to the Migratory Labor Hospital, Belle Glade, Fla., on February 17, 1944, because of persistent vomiting. The vomiting began seven months before admission, at which time it followed shortly after his meals. At first it occurred irregularly but became progressively more and more frequent. Most

water. The vomiting had never been projectile or contained any blood, and he had never noted any abnormal color of his stool. He never complained of any severe pain, but did have slight "heart burn and sour belching." He had lost fifty-five pounds in weight during the past six months. His appetite was poor, and he felt weak and short of breath on exertion. The patient never had any gastric complaints previous to the present illness. Twenty-five years ago he took five injections of "606." He has had no further treatment or other related diseases.

On admission the temperature was 98.6°F., the pulse rate 90; respiratory rate 18; and the blood pressure 110/80. The man was extremely emaciated with a very dry and loose skin. The thoracic cage was particularly prominent. There was no adenopathy except slight shotty nodes in the inguinal region. Heart and lungs were not remarkable. There was very slight tenderness in the mid-epigastrium, but no palpable mass could be found. The remainder of the examination revealed nothing significant.

Fluoroscopic and film study of the stomach with a barium meal taken on admission revealed an annular constricted area in the prepyloric region, cylindrical in type, and about 2 inches in length. (Fig. 1.) This segment appeared somewhat rigid, but the obstruction was not complete. Enough barium passed the lesion to fill the duodenum which ballooned out well, but the mucosa here appeared to be somewhat distorted. The remainder of the stomach showed a very irregular atypical mucosal pattern, and fluoroscopy six hours after the barium meal revealed about 50 per cent retention in the stomach.

An x-ray consultant\* interpreted the stomach film to be "probable carcinoma, possible gastric syphilis." Our clinical impression was the same.

The red cell count on admission was 4,200,000 with 74 per cent hemoglobin. The white cell count totaled 4,950 cells with 3 per cent eosinophils, 23 per cent lymphocytes, 15 per cent monocytes, and 59 per cent neutrophils. The urine showed slight trace of albumin and an occasional pus cell. The Kahn was strongly positive on two occasions. The stool was negative for blood. A gastric analysis showed total acidity of 17.6 with no free hydrochloric acid. Gastric washings were positive for blood and bile. An examination of the spinal fluid showed no increase in cells or protein and a negative Kahn. The plasma protein level was 5.8 Gm. per cent.

Peritoneoscopic examination revealed the liver to be grossly normal. There was considerable lymphadenopathy along the greater and lesser curvatures of the stomach, but no definite mass was discernable. The stomach wall had an abnormally red appearance, but no other details were made out. Gastroscopic examination was not done.

Because of the definite history of inadequately treated syphilis in the past, and the compatible lesion of the stomach, the patient was tried on soluble bismuth therapy plus a Sippy regime with belladonna and alkali for three and a half weeks. At the end of this period the patient was clinically unimproved. He always vomited after ingestion of solid food, and usually after water was given. He gained no weight. He had received four plasma transfusions and two clyses daily containing 1,500 cc. of glucose and saline with cevitamic acid,

\*Dr. H. S. Weens, Radiologist, Grady Hospital, Atlanta, Ga.

nicotinic acid, and thiamine chloride added. He appeared fairly well hydrated, but otherwise there was little change. Fluoroscopic and film study was repeated, and no significant change could be noted in the appearance of the stomach. (Fig. 2.)

An exploratory laparotomy was performed on March 15, 1944. At operation the prepyloric and antral portions of the stomach presented a greatly thickened and indurated wall which extended up approximately two-thirds of the entire stomach. The greater and lesser omenta were studded with enlarged edematous lymph nodes. The liver was grossly normal. The impression at that time was that this probably represented an annular carcinoma with marked surrounding gastritis and lymphadenitis. A resection was done removing four-fifths of the stomach along with all adjacent lymph nodes. A Hofmeister type anastomosis was done, bringing the jejunum anterior to the colon. (Fig. 3.)

The patient's post-operative course was uneventful. He was placed on a Sippy regime on the fourth day, and he gained 20 pounds during the next thirty days of his hospitalization. He has had no further pain or vomiting since discharge, and now does regular farm labor.

On opening the gross specimen of the stomach the mucous membrane was found to be completely replaced by nodular granulations which appeared intensely red. The pyloric mucosa and a small area just proximal to the pylorus appeared fairly normal. (Fig. 4.) The pathologist's report\* was "hypertrophic (sclerotic) gastritis with no evidence of syphilis or malignancy." (Fig. 5.)

#### SUMMARY

1. The literature on gastritis simulating carcinoma is briefly reviewed.
2. The criteria for surgical intervention in gastritis are listed.
3. A case of hypertrophic gastritis which could not be clinically distinguished from carcinoma and which responded well to resection is presented.

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DISRUPTION or eventration of abdominal wounds usually occurs between the seventh and eleventh days after operation, after the use of vertical incisions closed with catgut. Wound infection, drainage, cough or other strain favors the disruption. After a secondary closure, a secondary eventration may occur.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# REMOVAL OF METALLIC BODIES WITH THE AID OF A METAL LOCATOR

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THE removal of foreign bodies has always been accompanied by a considerable amount of uncertainty. Often an

approached a dial registers its proximity and a sound is heard. The nearer the locator is to the object, the higher the dial registers

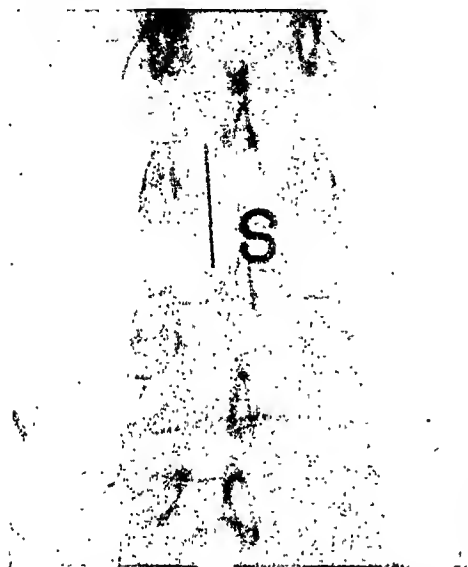


FIG. 1. Anterior posterior view of spine in Case 1.



FIG. 2. Lateral view of spine in Case 1.

apparently easy procedure becomes exasperating and time consuming. X-rays and the fluoroscope have greatly simplified the problem. A special technic for the removal of broken spinal needles has been described by Dr. Frank H. Lahey.<sup>1</sup> A metal locator has proved of great value in the accurate localization of metallic bodies. It was described by Dr. J. J. Moorhead in an article on his experiences at Pearl Harbor.<sup>2</sup> It was used by Dr. Moorhead in the removal of an intraspinal bullet.

The metal locator is manufactured in New York\* and is the invention of Samuel Berman. It is about the size of a portable radio. It works on the same principle as a mine detector—an electromagnetic induction apparatus. When a metallic body is

and the higher pitch to the sound. A reading may be taken on a similar metallic object to estimate the distance to the object to be removed. The following two cases illustrate its use:

## CASE REPORTS

CASE 1. Mrs. S. entered the West Suburban Hospital suffering from pneumococcic meningitis. During the administration of penicillin intraspinally an erusto stainless steel spinal needle broke off leaving about one and one-fourth inches in the back extending into the hiatus. (Fig. 1.) No immediate attempt was made to remove the broken needle. When the patient had fully recovered from the meningitis, a protracted and unsuccessful search was made through a generous incision. On April 13, 1944, the patient was again operated upon and, with the aid of the locator, the needle was re-

\* Waugh Laboratories.

moved in fifteen minutes. Convalescence was uneventful.

CASE II. Mrs. L. entered the West Sub-

was used by Dr. E. W. A. Alexander in New York in the removal of a needle from the heart.<sup>3</sup>



FIG. 3. Anterior posterior view of knee in Case II.



FIG. 4. Lateral view of knee in Case II.

urban Hospital May 22, 1944, complaining of a needle in her knee. She had been suffering from a painful knee over two years and had been treated for arthritis at several spas. Finally, after two years an x-ray disclosed the presence of a needle anterior to the knee joint and posterior to the patellar tendon. (Fig. 2.) The day following admission, an incision was made medial to the patella and the joint entered. The locator was introduced into the joint and showed the exact location of the needle. An additional small incision was made immediately over this site and the needle easily removed. The time for the removal was fifteen minutes. The patient was able to walk on the second postoperative day with practically no pain. She left the hospital on the sixth postoperative day and made a very satisfactory recovery.

#### COMMENT

The use of a metal locator will undoubtedly become more frequent due to its use by the armed forces. At Pearl Harbor its aid was dramatic. Recently it

Several points in technic might be in order. The operator of the apparatus must be scrubbed and gowned. The small tip that is introduced into the wound is covered by sterile latex. In introducing the tip into the wound one should avoid any pressure on the end of the needle as such pressure on a spinal needle has displaced it forward until it has been more difficult to remove.<sup>4</sup> Similarly, pressure by the tip on a needle in the knee joint has displaced it backward into the popliteal space.<sup>5</sup>

#### SUMMARY

1. A metal locator is a definite addition to operating room equipment.
2. Two case reports are submitted.

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# New Instruments

## A SIMPLIFIED HUMERAL SPLINT

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NUMEROUS types of splints for fixation of the shoulder and shaft of the humerus have been devised. Many bent manually or with bending irons to any desirable angle, thus producing a vertical or fixed portion, and a humeral or



FIG. 1. Splint consists of two padded galvanized tin plates, held together by a median malleable metal strip; three webbed straps are riveted to the median metal strip.

of these are cumbersome, difficult to manipulate, heavy and expensive. It occurred to the author that a splint, simple in construction, efficient and inexpensive would be advantageous. The purpose, therefore, of this paper is to present in concise fashion the details of a new type of apparatus which appears to fulfil all of the above criteria. The device has been used in sixty-nine cases of various types, such as, a number of fractures at the upper end of the humerus, dislocation of the shoulder, bursitis, tendonitis and as a convalescent support following open operation of and about the shoulder.

The splint devised consists of a strip of malleable metal, two galvanized tin plates, and three webbed straps. The malleable strip or "cold roll metal" is 18 inches long,  $\frac{3}{4}$  inch wide and  $\frac{1}{8}$  inch thick. It can be

movable portion. Adjustments can be made quickly, inasmuch as the metal strip lends itself readily to bending. A well padded galvanized tin plate, 8 by 4 inches, upon which the arm rests, is attached to the outer end of the humeral section of the metal strip with the aid of several rivets. In like manner, a padded galvanized tin plate 8 by 5 inches is attached to the lower end of the vertical portion of the malleable strip. This plate is molded against the side of the body above the crest of the ilium. The vertical metal strip is placed high up in the axilla and somewhat anterior to the mid-axillary line. Three webbed straps, each 48 inches long and  $1\frac{3}{8}$  inches wide are attached to the vertical strip at equal distances by means of a single rivet. The two lower straps are placed horizontally about the body, while the third strap is

fastened about the opposite shoulder. A collar and cuff, or cravat sling, may be applied from the neck to the wrist.

cealed within the sleeve of a shirt, dress or coat; and by rotating the straps completely around, with the individual rivets acting



FIG. 2. The metal strip has been bent to the desired angle (marked abduction) and the webbed straps are properly secured.



FIG. 3. The metal strip has been bent to produce moderate abduction.



FIG. 4. Humeral portion of the splint is concealed within a sleeve; the vertical portion may also be concealed.

There are other desirable features, such as pivots, the splint may be fixed to the right or left side of the body.



# A WALKING IRON WITH A FOOT PLATE

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WE have used the Boehler type of walking iron incorporated in plaster for fractures of one leg satisfactorily. However, a situation arose in which a patient fractured both os calcis. In this case our mechanic was instructed to add a sole foot plate to the iron. (Fig. 1.) To insure stability an angle bar was riveted from the front of the plate to the upright. For better locomotion a leather sole was riveted to the plate. The front of the plate has been bent slightly upward to overcome the tendency of scraping.

Since the first application there were three additional cases in which the mechanism was satisfactorily applied: (1) Fractures of both legs which necessitated the application of a Lane plate in one tibia. After six weeks walking was permitted with tight fitting casts in which walkers

were incorporated. (2) Fracture of both legs: one a spiral fracture through the middle of the leg, and in the other a plateau fracture of the tibia in which a Barr bolt was incorporated. Walking was permitted after five weeks. (3) An adult male with rigid flat feet was manipulated under anesthesia. After correction the feet were placed in extreme inversion and casts were applied in the same position. Walkers were incorporated on the following day and the patient walked about satisfactorily.

## SUMMARY

A modified Boehler walking iron is applicable in cases in which both feet and legs are encased in plaster. This allows for earlier locomotion with greater ease and stability.

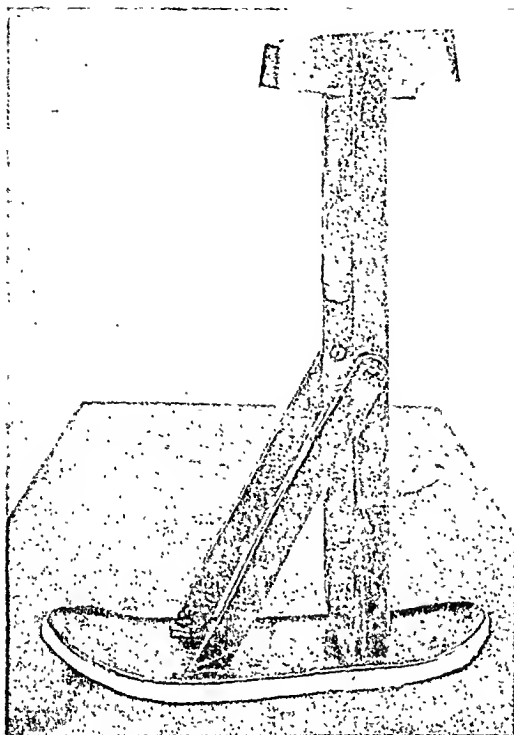


FIG. 1. Walking iron with sole plate.



FIG. 2. Front view; standing on both feet.

FIG. 3. Side view in act of taking a step.



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# Bookshelf Browsing

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ARNALDUS VILLANOVA

INCUNABULA MEDICA IX

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TO continue the direct sequence of the distribution or spread of medical knowledge in the thirteenth century, one passes from Fra Bartolomeo to his most illustrious pupil, Albertus Magnus, who in turn had two pupils who acquired world fame and were instrumental factors in moulding scientific and philosophic thought, Thomas Aquinas and Arnaldus Villanova. Arnaldus de Villanova did not reap the great worldly acclaim and fame of his teacher, nor that of his colleague. His life and his work have been more obscured, although from the standpoint of actual contribution to medicine he is usually as important as his three predecessors, if not more so.

There have been wide discrepancies of opinion as to just when and where he was born. It is believed that the year 1245 is probably correct, but the actual place of his birth has never been definitely established. Part of this confusion can be accounted for by his name "villanova." Some have believed that this was probably the name of the town where he was born, as it was a custom of the time to adopt the name of one's birthplace. The literal translation of his name, "Arnaldus from Villanova" would fit into this concept. The name being of Italian or Spanish derivation, it was thought by some that he was either a Spaniard or an Italian. There existed in Spain, and also in France, in the Provence region particularly, many small villages called Villanova and each one of these laid some claim to being

the birthplace of Arnaldus; none, however, was able to support the claim.

French authorities claim that he was a Frenchman, born in a small village called Villeneuve-Loubet in the Provence region. They base this claim on the fact that he once dedicated one of his works to Robert, King of Naples and Count of Provence, stating in the dedication page that the work was from one of Robert's loyal subjects. Documental historical evidence also exists that a very wealthy and royal family named Villeneuve lived in the eleventh and twelfth centuries and part of the thirteenth in Provence, and that this town of Villeneuve was a part of their royal domain. Those who claim other origin for Arnaldus state for authority that in the preface of his book "De Vinis" he writes, "Poverty was my companion in my younger years," and that, therefore, he could not have sprung from such rich and powerful people. These biographers maintain that the French authorities have also confused him as being of another family, that of the Marquis of Villeneuve, royal, rich and endowed with vast domains. However, the debated point as to where and when he was born is really of little significance when compared to the story of the man himself and his achievement.

He first attracted attention at a small school at Aix, in France, where he studied mainly languages, Greek, Hebrew and Latin. As it was essential to the study of medicine at that time that one should be familiar with Arabic, he was next

heard from as a student in Spain, at the source of existent medical manuscripts, and where all of the medical texts were in the Arabian language.\*

It is then supposed that his medical studies proper were acquired at the University of Montpellier, back again in France, and that at the time of his studying there he was probably about twenty-five years old. That this is possibly very true is confirmed by the fact that there exists a written manuscript in the form of a Papal Bull, issued by Pope Clement V about the year 1270, covering the rules and regulations for obtaining credits at the University of Montpellier, based upon information and facts furnished the Pope by one Arnaldus Villanova, and his name is specifically mentioned.

There exists also another manuscript which is owned by the University at Cambridge corroborating his connection with Montpellier at this time. The title of the manuscript is:

"LIBER DE REGIMINE VITAE HUMANA EDITUS E PERITO VIRO, MAGISTRO ARNALDO DE VILLANOVA, IN PRAECLARO STUDIO MONTISPESS VLANI."

Following his studies at Montpellier he is supposed to have returned to the town of Villeneuve in Provence and to have practiced medicine there and in the surrounding country. Feeling, however, that his medical knowledge was rather meager he returned once again to Montpellier to study physics and philosophy. In order to clarify further that he could not be the son of a royal or wealthy family, it is known that his means of

support while at the University was derived partly from tutoring and partly by practicing medicine whenever the opportunity offered itself.

Having completed as much as it was possible to obtain at Montpellier in the study of the sciences, he went on to Paris, which at this particular time enjoyed a tremendous reputation among the learned and intellectual throughout Europe. This reputation was principally because of the presence there of Albertus Magnus, as a lecturer of the Faculty, considered the most able and brilliant mind of his time.\* Here Arnaldus met as fellow students Thomas Aquinas and Roger Bacon. These two represented the keenest minds among the many learned students who had flocked to Paris from all over Europe in order to hear the Dominican Albertus Magnus lecture. In Paris, amid such favorable environment, Arnaldus buried himself in the study of philosophy and theology.

The philosophy which Albertus Magnus expounded was that of Aristotle, except that he tried to reconcile all of his theories and hypotheses to the general laws of nature, as it existed in everyday surroundings and actions, and also to adapt this philosophy to the laws promulgated by the theology of the Church that it might be acceptable to such a powerful body.

As mentioned previously, Arnaldus was obliged to earn funds for his existence. In Paris, therefore, he set himself up as a tutor to younger and more immature students and practiced medicine as a sideline when possible. In this respect he differed materially from his teacher, Albertus Magnus, and his fellow student, Thomas Aquinas, both of whom were extremely wealthy and came from very prominent and powerful families.

Arnaldus spent ten years in Paris studying philosophy and practicing medicine, then returned once again to Montpellier.

\* The names of Rhazes, Avensoar, Abucassis were the heritage of Spanish medicine, and these names lived on from their much earlier times in the written manuscripts which they had left behind and which in most cases had become the property of either royalty, in the persons of the Spanish kings, or of the Popes, etc. The Dominicans and Franciscans were avid collectors of scientific and philosophical manuscripts, but of course, could not compete in a situation where, more often than not, the author dedicated his opus to his king, or if more religiously inclined to the Pope, and presented him with probably the only copy then existent.

\* Cunha, F. Albertus Magnus. *Am. J. Surg.*, 64: 420, 1944.

Montpellier had acquired a world wide fame because of the excellence of its school of medicine. Many famous professors attracted large numbers of students to the school. It was not long before Arnaldus himself attracted considerable attention and favorable comment, because of his own store of knowledge. He was able to obtain a professorship at the University, which he not only desired, but actually needed. The professorship carried a small stipend upon which he could live.

In the Archives of the University the following notation was recorded by a later President of the Faculty: "In the entire history of our school its period of greatest glory was undoubtedly that of the Middle Ages, and the greatest name during this period was without any doubt that of Arnaldus of Villanova, the first one of the great doctors and surgeons who struck out originally along original and untrod paths and did not follow slave-like the precepts of the Arabian and Greek teachings." This is all the more significant in that, although steeped in the Arabian as the result of his residence and studies in Spain, he was sufficiently individualistic to break away completely from this influence.

In spite of the fact that his fame and practice became all that could be wished for in Montpellier, he apparently could not be held in one place for any great length of time. Desiring to know even more about the medical dogmas of the old Arabian doctors, he went to Spain again in order to be in the very heart and midst of these teachings, where he might have personal access to the original writings. His reputation at Montpellier preceded him to Spain, and he arrived in Barcelona in 1286 amid great popular acclaim. These were the days when intellectual capacity, although possibly envied, was admired and cheered by the mob, in strange contrast to the reaction of supposedly more enlightened times.

He found it necessary, however, to

study more deeply and intensely the Arabian language, so that for some space of time he did not engage in either teaching or medical practice, except for one most notable instance. This was the case of his Highness, Pierre III, King of Aragon, who was dangerously ill of some unknown malady, and Arnaldus was by royal command ordered to see him in consultation. The disease was apparently an obscure one and history has not recorded details, only that, despite all medical care, it was not possible to save the King's life and he died a few days after this consultation. The unsuccessful outcome of this prominent and illustrious case disturbed Arnaldus mentally to such an extent that, in spite of all efforts on the part of his friends and scientific brethren to keep him there, and in spite of promises of even great rewards from royalty, he would not remain any longer in Spain.

The story has been fabricated that because of the lack of success in this prominent case, he was excommunicated from the Church and forced to leave Spain, that he did not leave entirely of his own accord. At any rate, whichever of these two versions of his reason for leaving Spain was true, he was next heard from in Italy. Here he became interested in that fetish of the Middle Ages, the transmutation of base metal into gold, the stone of the philosophers, the search for a Golden Fleece, and it is recorded that he gave a public demonstration in the great square of Rome of the transmutation of mercury into gold. Whether his interest in alchemy was pecuniary, fostered by a desire to acquire riches, or merely a sincere attempt to prove or disprove those results which were reported everywhere as having been obtained by possessors of the secrets of alchemical science, it is difficult to say.

From Rome he journeyed again to Paris, there to lecture in botany and medicine at the University, but this time he ran into a multitude of difficulties because

the doctrines which he expounded in his lectures were contrary to those taught by the Church. Some of these are of interest: He maintained that works of charity and such, as, for example, the practice of medicine, were much more agreeable to the eyes of the Lord than the celebration of mass. He could hardly have expected the Church to allow that opinion to pass on, placing doctors on a higher social and religious plane than priests. Another of his teachings was that only those would be condemned to damnation who by themselves set a bad example. Still another was that Papal Bulls were only the work of a human and were not handed down by Divine hands or inspiration. He was against all religious orders, Dominican, Franciscan and otherwise because they were more political than religious. Is it any wonder that he and his writings were relegated to obscurity by the ecclesiastical hierarchy?

At this time in Paris astrology was the fashionable and popular science, so Arnaldus began to lecture on the influence of terrestrial bodies upon earthly events, such as the action of the moon, the position of the sun, etc. It is recorded that once he overstepped himself and went to a height of absurdity in his lectures, by proclaiming that the end of the world would take place in the year 1335. Explanations of this pronouncement only added to his academic difficulties.

Having incurred already the persecution of the Church, he had now exposed himself by such statements to the inquisition of Pope Alexander IV, who had established Inquisitors all over France at the request of St. Louis, King of France.

Arnaldus found that it would be rather dangerous to his person to remain in France any longer and it is thought that he went to Naples, where he had some time earlier been offered the post of physician to King Charles II. Others claim that at this time he returned to Spain in another attempt to study more deeply the science of the Arabian physicians.

In historical documents, however, it is

recorded that at this time he became entangled in political matters in Spain, in the rôle of ambassador to Naples for Frederick II, King of Sicily and a brother of King Charles of Naples. Apparently a warm personal friendship with King Charles ensued and he remained in Naples, not only as personal physician to the King, but also in the rôle of intimate counsellor. This was due in part to the fact that the King of Naples was an intellectual, an ardent student, a seeker of knowledge, and desired naturally to have about him a man possessing the mental caliber of Arnaldus.

Here, under the patronage of the King, he published only one manuscript, which was apparently of little importance as there exists little literature concerning it.

He could have remained in Naples under the patronage of the King, living at ease to a ripe old age, but again wanderlust, or a restless inquiring mind occupied with little intellectual effort in Naples, caused him to move on again to Paris. He advanced as his reason merely that he desired to publish his works in Paris where more satisfactory surroundings existed for the writing and arranging of manuscripts.

He therefore left Naples and en route passed through the town of Avignon where his fame had preceded him. He was offered the post as personal physician to the Pope, Clement V; but in spite of the many advantages which the position might give him, he refused it and continued on his journey to Paris. It has been pointed out by historians that the story of his having been excommunicated from Spain could not have been a true one, as otherwise he would never have been offered the post of personal physician to the Pope.

It was this Pope, Clement V, who later issued a Bull with regard to the University of Montpellier, in which mention is made of Arnaldus de Villanova as professor of medicine and science.

Arriving in Paris he set himself immediately to convert his vast amount of notes



into manuscript form for publication. In those times, publication meant that perhaps three, four, possibly a few more copies of these notes would be transcribed by hand onto vellum or parchment by scribes proficient in that work, possibly illuminated by an occasional inspired one, and then these copies would pass from hand to hand to be read by interested scholars. Later some desirous soul, eager to labor, might set himself down to make a copy for his own personal use, or have it copied by a paid scribe. This process was to repeat itself over and over again until two hundred years later, when with Gutenberg's discovery of the process of printing, came the transition stage of knowledge, the passage from the hand written manuscript to the printed page.

The greatest mistake Arnaldus made was in repeatedly suggesting reforms in theological science, which were particularly distasteful to the Church. A Dominican, Bzovius, professor of theology at Bologna, published a work of his own in which he excoriated Arnaldus as being in league with the devil, and claimed that very good evidence of this was his ability to transmute metals into gold. He also took up various parts of the theories promulgated and published by Arnaldus, and by changing a word here or there, altered the meaning of the text completely and tried to make it appear that the entire work was an absurdity—and he succeeded in no mean degree.

The Dominican also attacked the symbolical or mystic language used by Arnaldus in describing his alchemical experiments. As nobody knew exactly the meaning of any of these symbols, he attempted to make the entire work appear absurd and ridiculous.

On top of all of this controversy, a charge of heresy was launched against Arnaldus' works by his own alma mater, the University of Paris, egged on mainly by the Inquisition. An order was issued for his arrest. As trial before the Inquisitor usually ended by being burned at the

stake along with one's writings, it was time to move on. After undergoing numerous risky escapades getting away, he succeeded in reaching a seaport of France and left secretly by ship for Sicily.

The King of Sicily received him with all the distinction accorded to a fugitive genius of science. He gave him his official protection against the Church and all of his enemies. Apparently Arnaldus was predestined to keep on the move, however, and not to remain in any one place for any length of time because he soon moved on again.

Pope Clement V, who had offered Arnaldus the post of personal physician, had become dangerously ill at Avignon. He sent for Arnaldus, offering to have all persecution of him by the Church stopped and all laws promulgated against him lifted. So Arnaldus is found again on the way to France, sailing from Sicily. This voyage, however, was to end that ever present wanderlust, because just as the ship was in sight of the French coast, he became violently ill with some abdominal ailment and died before he could land. This was in the year 1313.

Pope Clement had admired the medical ability of Arnaldus so much, that Arnaldus in turn, while in Paris publishing his works, had dedicated a volume entitled "Praxis Medica" to him. After his death it could not be found, although a careful search was made under the personal orders of the Pope.

Although Pope Clement has ordered that all bans of the Church against Arnaldus were to be lifted, four years later before a tribunal of the Inquisition thirteen of his books were placed on the proscribed list and condemned to be destroyed.

In spite of his apparently roving, hectic life with its attendant difficulties and persecutions, Arnaldus is to be ranked as one of the greatest minds of his century. As a philosopher and as a practicing physician, he enjoyed a tremendous reputation among his contemporaries.

One has to search, of course, for a reason for this reputation and there is no better place to search than in his own writing. He published a large number of manuscripts, although mostly they were very short. They consisted more of a compilation of his personal experiences in cases and in consultations, rather than of true text treatises on any particular subject.

As an example of his studiousness and his research, his tract "De Venenis" contains a description of an excoriation of the intestinal tract produced by arsenic which is so accurate that it could only have been made by Arnaldus defying the law and prejudice of his time and opening the cadaver after death and recording the findings.

The most important of all his works is his "De Vinis." Here he describes the methods of preparing alcohol, distilling of essential oils, medicinal wines, etc. A large number of the substances which he describes are taken from Oriental sources and are not original with him; but they were unknown to his time and to his contemporaries, and it was his diligent study and research which brought them to light. Many originated with Pliny and had been previously described by him.

The "De Vinis" was dedicated to the King of Sicily who had befriended him.

The process of distillation, although originated by the ancients, had fallen into disuse and been almost completely forgotten, but was revived by Arnaldus allying it to chemistry and pharmacy and adding it to the medical armamentarium, a contribution to medicine and to pharmacy.

Another treatise "De Ornatu Mulierum" was on cosmetics, with formulae for the care of the skin, the hair, the nails, etc., so that the art of female adornment was even in that day of sufficient importance not only to engage the best minds of the time on the subject but even to have a dedicated work written upon the subject.

All of the tracts condemned by the Inquisition have disappeared, supposed

to have been fourteen in number. Those which escaped the Inquisition, and which comprise the true first editions of his works, were printed at Venice, then later reprinted at Basle, still later at Lyons, and are all composed of either medical or pharmaceutical subject matter. It must be borne in mind that printing did not come into use until 1456.

Some authorities believe that the alchemical tracts are not truly of his authorship. It was quite the custom in the Middle Ages for less celebrated personages to publish writings under the name of famous men, and to this custom is attributed the large number of treatises attributed to Albertus Magnus and also Arnaldus Villanova, and much of the fantastical and nonsensical in these times is considered to have originated with lesser intellects. The custom also furnished an excellent ground, or loophole, on which later to deny authorship of anything that became too controversial, or that passing years demonstrated to be fallacy.

Hippocrates maintained that a physician had to be well grounded in philosophy, history and in astronomy. Arnald of Villanova, tying in astronomy more closely with medicine, followed, more or less, the idea of Hippocrates with one possible criticism, mainly that he exaggerated the influence of astronomy. In his lectures and teachings he attributed to the stars and the moon many of the changes in the human body, stressing that many medical treatments should not be carried out unless the moon was in a propitious part of its cycle. These ideas were prevalent amongst all of the wise men of the Middle Ages, and it was sometime later before they were to be shaken off.

It is of interest that Arnaldus stressed the idea that physicians should study the mental attitude of their patients and attempt to relieve them of fear, anxiety, worry, and to change their attitude toward matters in general by a proper system of explanations, a sort of psycho-analysis, and a perfect rationale for the treatment of

a multitude of the functional disturbances that we, as physicians, see today.

Other of his published works are the "Rosarius Philosophorum," an obscure philosophical dissertation; "De Sigillis"—The Talisman, a combination of astronomy and medicine; and "Novum Lumen"—Eternal Light, a similar treatise.

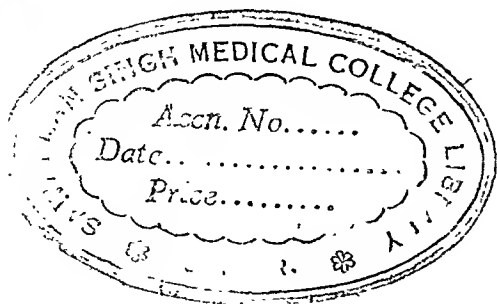
His works are considered generally to have been written in very poor, literary style, with much miswording and misspelling. This has been attributed to his being always overburdened with work and not having sufficient time for re-reading and correction.

His most popular work, and one about which there is some question as to his actual authorship, was a collection of

home recipes and prescriptions called the "Poor Man's Treasure" which was widely used and quoted for sometime after the thirteenth century.

A considerable collection of his works, in manuscript form, and several portraits of him, form a part of the library of the University of Montpellier, dedicated to its most distinguished and illustrious students.

He formed a link in the chain of dissemination of scientific knowledge, mainly of medicine and philosophy, bringing together that which had gone before, adding a humble bit, then passing it on by means of the written word, that in like manner those who came after might have the opportunity to maintain the strands intact.



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# Original Articles

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## AIR EMBOLISM\*

WITH SPECIAL REFERENCE TO ITS SURGICAL IMPORTANCE

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**M**OST surgeons regard *air* and *fat embolism* as more or less nebulous entities, which are rarely serious enough to cause concern. Both these conditions occur, however, more frequently than is suspected, and fatalities are occasionally encountered. These deaths are usually sudden but may at times be somewhat protracted.

The author, therefore, believes that the type of case in which *fatal air embolism* may occur should be emphasized, and the clinical symptoms and pathological findings reviewed.

Air embolism is the result of the entrance of air into the venous circulation (or occasionally the systemic circulation), with consequent blockage of the right side of the heart and the pulmonary circulation, or the cerebral or coronary circulations. Blockade of vessels in other locations are of no practical significance, since no disastrous results ensue.

For air embolism to produce death, air must enter the circulation in *large quantities* in a *short period of time*. Even large quantities of air may enter the circulation over a long period of time without fatal results. For instance, a liter of oxygen has been injected into man in the course of an hour without serious injury. Of course oxygen is more readily absorbed than air which contains only 21 per cent oxygen.

Small quantities of air rarely produce

death unless the air is trapped in the coronary arteries or in some vital cerebral location.

There are *two main varieties* of air embolism: *Pulmonary embolism* which is much more frequent and important, and *systemic embolism*.

### FATAL PULMONARY AIR EMBOLISM

When a large volume of air reaches the right side of the heart in a short period of time, foamy blood containing large bubbles of air is formed. This is more compressible than normal blood and less readily expelled, a considerable amount of air remaining after each systole. Thus, the pulmonary circulation becomes obstructed, the right auricle and ventricle are distended and tympanitic, the peripheral venous pressure is increased and sudden death occurs due to interference with proper ventricular contraction. (Fig. 1.)

*Symptoms.* Shortly after the onset, the patient becomes dyspnoeic, cyanotic and pulseless. Death usually occurs in a few minutes. The clinical mode of death is similar to that observed in massive pulmonary embolism, such as occurs after thrombosis of the veins of the lower extremity. There is an "acute cor pulmonale."

*Autopsy Findings.* Air embolism of this type can often be suspected from the history of the case and the conditions under which death has occurred. No death from

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air embolism, however, is proved unless proper autopsy technic is used for its demonstration. Two methods are in use:

(1) After opening the chest and abdominal cavities, all great vessels are ligated, including the inferior vena cava and the lungs and heart removed *en masse*. They are then immersed in a basin of water and the right ventricle incised. Air bubbles escape if air embolism is present.

In routine medicolegal autopsies, I have opposed any autopsy technic in which organs are removed *en masse*. The organs are pulled and dragged out, artefacts are common, and important evidence is often missed or destroyed.\*

(2) For the above reasons I prefer the original Virchow autopsy technic, in which nothing is disturbed until it has thoroughly been investigated, and the organs are removed in a logical and methodical manner. Thus, in the demonstration of air embolism, the abdomen and chest are carefully exposed. The sternoclavicular joints and the cartilages of the first two ribs are not disturbed for fear of cutting the vessels of the upper chest and the lower two-thirds of the sternum removed without undue force. The pericardium is opened and the heart exposed.

In the pulmonary type of air embolism, the right side of the heart will be found distended, often ballooned out and tympanitic on percussion. The inferior and superior vena cavae will be distended with what appears to be frothy blood. Then, the pericardium, chest and abdominal cavities are filled with water. The heart often shows a tendency to rise to the surface. It is held back below the surface of the water and the right ventricle is then incised. In pulmonary air embolism large bubbles of air and frothy, foamy blood escapes. The inferior vena cava may then be punctured under water.

\* The "en masse" autopsy technic, often called the Le Count method, is very popular in this country. In general, I believe its use, as a routine procedure, is very apt to lead to careless and incomplete autopsies. It has some special advantages, however, which are limited.

It is important that the autopsy be performed as soon as possible after death, so that air embolism is not confused with the gases of decomposition. There should be no visible signs of such decomposition, i.e., no hemolysis in the blood or reddish staining of the endocardium or intima of the veins.

#### FATAL SYSTEMATIC AIR EMBOLISM

In a few cases, air may enter the left side of the heart in the form of foamy, frothy blood containing small air bubbles. Systemic air embolism results. As a rule the air is rapidly absorbed producing little or no symptoms unless it reaches the brain in considerable amounts or is caught in the coronary circulation. The effect of air in other organs is negligible.

In most of these cases the air has originally entered the venous circulation resulting in pulmonary air embolism. Death, however, has not occurred and small amounts of air in the form of fine bubbles have passed through the lungs or through a patent foramen ovale into the left side of the heart.

Though a patent foramen is found in 25 per cent of individuals, the opening is usually small and physiologically closed by the higher pressure in the left auricle. However, in shock, when the pressure in the right side of the heart may approach that in the left side, paradoxical embolism may occur.

Air may also enter directly into the left side of the heart from injury to a pulmonary vein without entering the venous circulation. This may occur during artificial pneumothorax.

In addition, air may enter the vertebral system of veins and pass directly to the brain, by-passing the heart. Such embolism may occur in air insufflation around the adrenals for their roentgenographic visualization.

**Cerebral Air Embolism.** Usually if considerable air reaches the left side of the heart, the brain is likely to receive most of it. Cerebral air embolism is charac-

terized by usually a *slow mode of death*. The patient lives a few days as a rule in a maniacal, stuporous or comatose condition.

The characteristic autopsy findings in

in fat embolism, and from concussion hemorrhages in blunt force injuries to the brain and the various forms of hemorrhagic encephalitis.

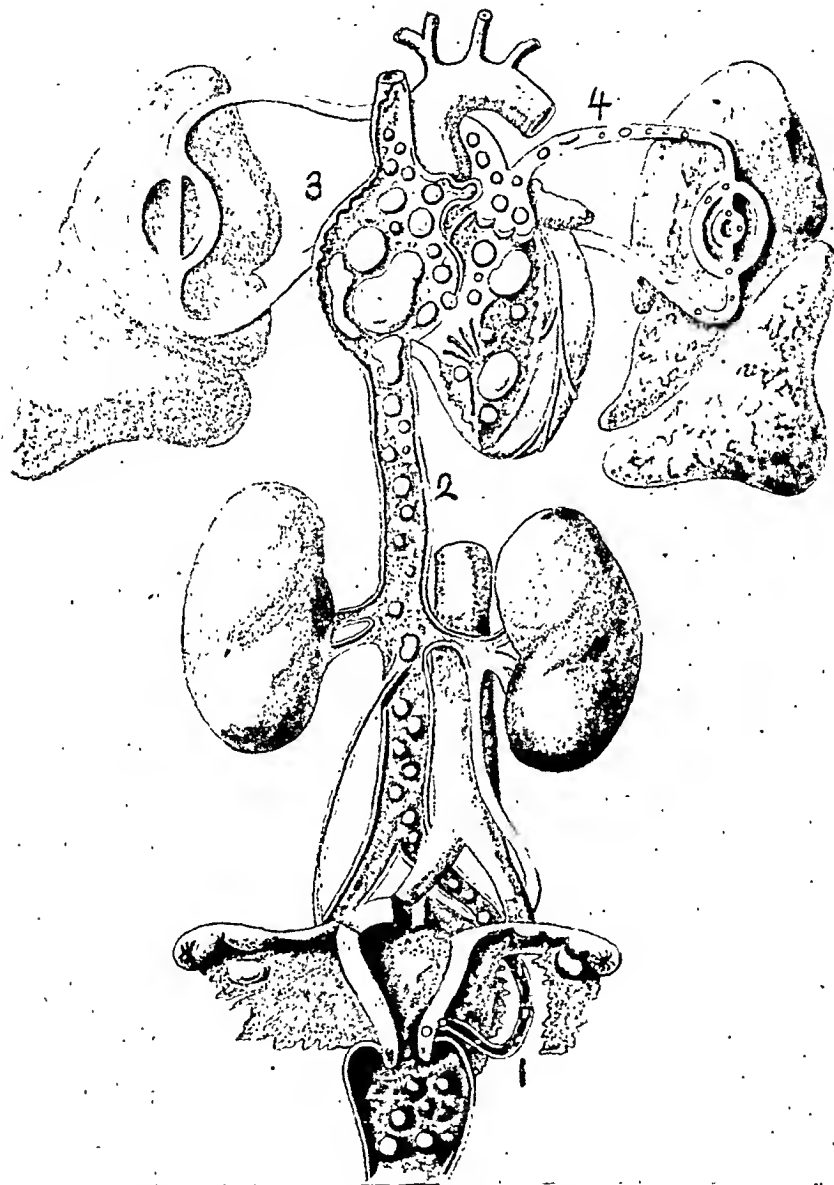


FIG. 1. Fatal air embolism of the pulmonary type. (1) Entrance of air into uterine veins; (2) air in inferior vena cava; (3) right side of heart distended with foamy blood and large air bubbles preventing proper systoles; and (4) foamy blood containing smaller air bubbles entering pulmonary circulation. Case of sudden death following intravaginal powder insufflation for treatment of pruritus.

such cases are *multiple petechial hemorrhages* throughout the white matter of the brain. These must be differentiated from similar appearing hemorrhages encountered

Air bubbles in the veins of the leptomeninges are usually an artefact occurring in the routine removal of the brain and are of no significance.

*Coronary Air Embolism.* Should the coronary circulation be blocked by air, sudden death results. This is difficult to systemic air embolism has been observed under a variety of conditions. They may be briefly discussed as follows:

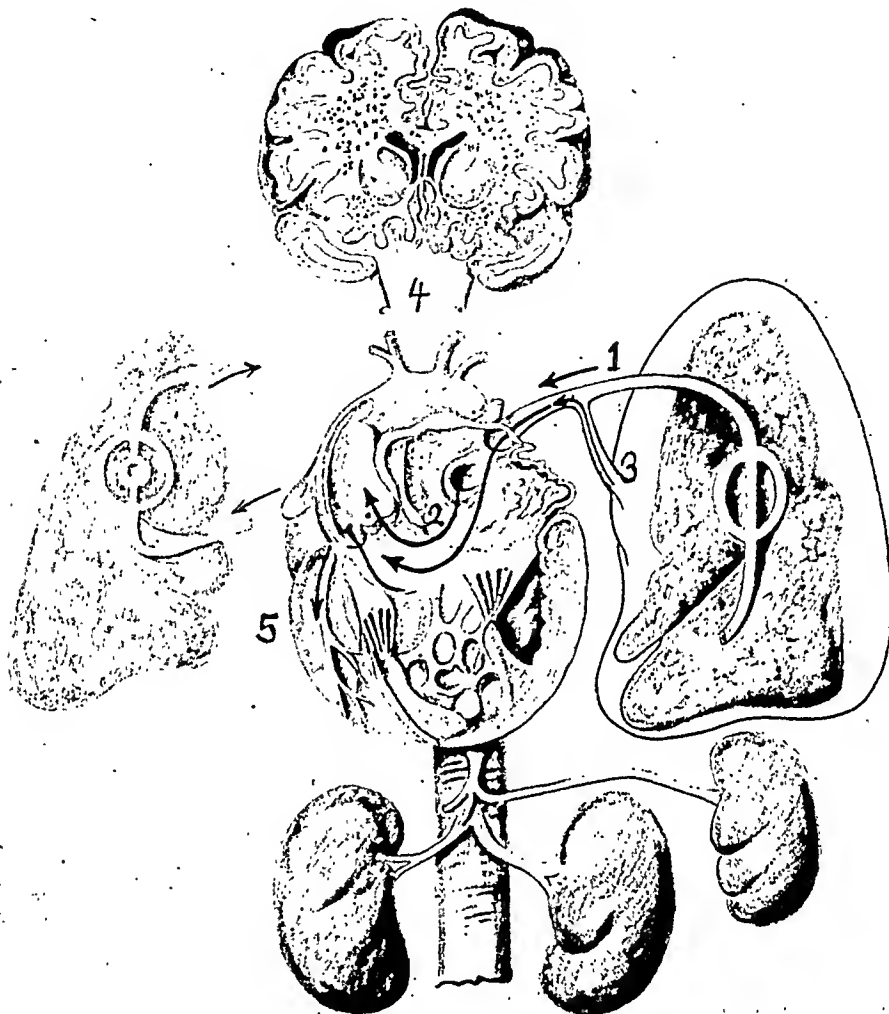


FIG. 2. Fatal air embolism of the systemic type. Note air entering the left side of the heart (1) from lungs, (2) through patent foramen, and (3) through pulmonary vein injured during artificial pneumothorax; (4) cerebral air embolism with multiple hemorrhages in white matter; (5) coronary air embolism.

prove at autopsy, since air bubbles are frequently sucked in during routine removal of the heart. The anatomical pathways in air embolism of the systemic variety is shown in Figure 2.

#### VARIOUS CONDITIONS IN WHICH FATAL AIR EMBOLISM MAY OCCUR

*Fatal air embolism* is almost always of the *pulmonary type*. In the experience of the medical examiner, both pulmonary and

*Head.* Wounds or operations in which the dural sinuses are injured may cause air embolism. The walls of these sinuses are stiff, therefore, do not collapse easily and favor the entrance of air.

*Lavage of the Nasal Sinuses,* especially the antra Highmori, has been followed by immediate death. The author knows of three sudden deaths in clinics and physician's offices from this procedure.

Air under considerable pressure (often five to ten pounds) is blown through the antrum to replace the irrigating fluid. Great care should be taken to control this pressure. Often in office buildings, compressed air is piped to individual offices, and is not regulated by pressure gauges or reducing valves. Pressures may vary and reach dangerous amounts.

*Neck and Upper Chest.* Wounds and operations in the region of the carotid vessels may cause air embolism. This is particularly true when the jugular vein is injured, during thyroid operations, in the removal of tumors of the neck, in the repair of arteriovenous aneurysms, et cetera. The surgeon may notice a hissing sound or "soufflement" as air is sucked in. Death may quickly follow as the right side of the heart is rapidly filled with air.

Any type of wound or operation in the neck or upper chest which cuts or penetrates large veins of the neck or mediastinum may be complicated by air embolism. Sometimes the air may enter the left side of the heart from injury to a pulmonary vein.

*Peripheral Veins.* Seldom is any large amount of air injected in the peripheral veins. Small amounts frequently enter in various intravenous injections but rarely produce symptoms.

Fatal air embolism, however, has been observed after continuous intravenous injections, especially when tubing has slipped and becomes disconnected and air is sucked in for several minutes.

In blood donations, using closed types of apparatus, air has been forced into veins of donor or recipient, by unwittingly connecting the positive pressure tube to the individual, with resultant serious reaction.

*Urinary Bladder.* Air embolism has occurred after injections of air into the urinary bladder for the purpose of taking aerograms or for operative or therapeutic purposes. Ulceration of the bladder favors the entrance of air.

*Uterus.* Fatal air embolism is, however, most frequent after injection of air into the uterine cavity.

*Criminal Abortions* are the most frequent cause of fatal air embolism. It usually occurs in dirty abortions, often performed by midwives using the old Hungarian syringe method of injecting soap-suds and air directly into the uterine cavity. Such fatalities are sometimes accompanied by fat or oil embolism. The placenta is often torn and partially separated allowing large quantities of air to rush into maternal sinuses and uterine veins.

*Obstetrical Cases* have been complicated by air embolism, especially at the delivery of cases of placenta previa.

*Diagnostic and Therapeutic Uterine Injections* have been followed by air embolism, with occasional fatal results. In testing the patency of the Fallopian tubes (Rubin test), physicians have occasionally observed sudden collapse and even convulsions, from which, fortunately, the patients have recovered. Fatal air embolism has occurred. The air injections should be carefully controlled and pressures not exceeding 150 mm. of Hg. should be used. Some physicians have been using dangerous pressures of 200 mm. or more.

*Intravaginal Insufflations* for the treatment of trichomonas infections and pruritus have caused sudden death from pulmonary air embolism.\* In these procedures the vagina is intentionally distended with air so that its folds will be smoothed out, allowing medicinal powder to cover its walls.

*Transuterine Pneumoperitoneum* for pneumoroentgenographic diagnosis could easily be complicated by air embolism, especially if attempted near a menstrual period, or after uterine curettage.

*Peritoneum.* *Direct Pneumoroentgenography* is usually not considered to be a dangerous procedure. However, the puncture of a large intra-abdominal vein could result in air embolism. If the vertebral system of veins were injured, air might

\* MARTLAND, HARRISON S. Fatal air embolism due to powder insufflators used in gynecological treatments. *Am. J. Surg.*, 68: 164, 1945.



by-pass the heart and go directly to the brain, resulting in systemic air embolism of the cerebral type.

**Pleura.** *Artificial Pneumothoraces* are often complicated by air embolism but death rarely results, and recovery is followed by no sequellae. In some one in every 500 or 1,000 artificial pneumothoraces the patient may suddenly feel queer, often go into temporary shock and even have a convulsion. In the rare fatal case, air embolism has been reported, the air gaining access to the systemic circulation through an injured pulmonary vein. Some authorities, however, do not believe that these reactions are due to air embolism and attribute them to some unexplained pleural-cardio-inhibitory reflex.

As these deaths are said to be sudden, and as sudden death from cerebral or coronary air embolism is difficult to prove at autopsy, I am of the opinion that the cause of death in these cases is still controversial.

**Retroperitoneum.** Air insufflations in the region of adrenal glands for the roentgenographic visualization of adrenal tumors, etc., have been followed by death said to have been due to air embolism. It is possible in this procedure to injure vertebral veins and have direct cerebral air embolism.

#### CONCLUSIONS

1. The various conditions in which *air embolism* may occur have been discussed. Most of these are mainly of surgical interest. The introduction of air under pressure into the uterine cavity is the commonest cause of air embolism.

2. Air embolism is not often a serious

complication, and gives rise to little or no symptomatology whatsoever. Reactions which are sometimes alarming, such as collapse, shock and even convulsions, may occur but these are often recoverable leaving no sequellae.

3. Fatalities occasionally are encountered. The common type of *fatal air embolism* is the *pulmonary type*. In this form large quantities of air reach the right side of the heart in a short period of time and interfere with proper ventricular systoles and results in sudden asphyxial death.

4. A less common form of *fatal air embolism* is the *systematic variety* in which *cerebral air embolism* is the most important. Deaths in these instances are protracted, sometimes taking two to five days, during which the patient is maniacal, stuporous or comatose. The characteristic pathological lesions are multiple, petechial hemorrhages in the white matter of the brain.

In rare instances *coronary air embolism* causes sudden death. This is difficult to prove at autopsy and many cases in literature would not bear critical analysis.

5. Greater care should be used in the various diagnostic and therapeutic procedures which depend upon the introduction of air under pressure into the vagina, uterus, urinary bladder, peritoneum and perinephric space in order to prevent such catastrophes.

Precautions should be taken in operations around the large veins of the neck, upper chest, mediastinum and dural sinuses to prevent air embolism as a complication. And the possibility of air embolism in gunshot wounds, stab wounds and cuts in these locations should be borne in mind.

# HERNIA IN INFANCY AND CHILDHOOD

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**A** CONGENITAL inguinal hernia is one wherein an abdominal organ, an associated structure or both descend into a partly, or completely, open processus vaginalis peritonei.

## ETIOLOGY

*Predisposing Factors; 1. Heredity.* Heredity appears to play a distinct rôle. Kingdon, many years ago, recorded a 34 per cent ratio, which is too low. Astley Cooper stated that hereditary factors were of indubitable importance in the incidence of hernia.

The statistics of our day are to the general effect that the hereditary basis accounts for at least 25 per cent of all varieties of hernia, especially in infants and older children. Birkenfeld (*Arch. f. klin. Chir.*, 1930) wrote that the familial congenital predisposition in men is four times greater than in women.

A significant fact, obvious from world-wide data, is that about one male adult in 500 on examination reveals a maldescended testicle. This developmental "fault" runs in families.

It has likewise been shown that there are hereditary abdominal muscle anomalies (due to endocrine dysfunction) which predispose to hernias of all varieties. (Fig. 1.)

When the testicle descends from its embryonic retroperitoneal position it carries peritoneum along with it through the inguinal canal and into the scrotum. The potential sac thus formed, the processus vaginalis, becomes obliterated (sometimes prenatally) through its entire extent, with the exception of the part which envelops the testicle. This portion is the tunica vaginalis. The part which parallels the spermatic cord is the funicular process

which, under normal conditions, closes throughout its extent. If this does not occur antenatally, a direct communication remains from the peritoneal cavity to the testicle, permitting the abdominal viscera or associated structures to descend into the scrotum. When the lumen of the funicular process is obliterated, only its initial part, the portion persisting, the proximal end, permits the ingress of a funicular hernia. This is the most common congenital variety.

When the lumen of the funicular process is obliterated in its proximal extent, fluid may accumulate in the distal portion of the process and in the tunica vaginalis of the testis forming a hydrocele. The lumen of the process may be obliterated at each end, but remain open somewhere in its extent. When fluid accumulates here, it forms a hydrocele of the spermatic cord. (Figs. 2 and 3.)

During the ninth month, after the descent of the testis has been completed, the processus vaginalis is occluded in two situations, at the anulus inguinalis profundus and immediately above the testis; the intervening part normally becomes obliterated. A patent process which communicates with the abdominal cavity is the basic, etiologic factor in the development of inguinal hernia, congenital or acquired. A patency between the two sites of obliteration is the predisposing factor of a hydrocele of the spermatic cord. (Figs. 4 to 11.)

*2. Sex.* The preponderant incidence of indirect inguinal hernia in males is due to many embryologic, as well as anatomic factors, to wit: (1) The greater incidence of an imperfectly closed processus vaginalis in men than in women. (2) the descent of the testicle, and (3) the requirement for

a larger aperture for the exit of the spermatic cord. In the early years of life the inguinal region area, among other peculiari-

The importance of these factors is greatest in the newborn child. In a large proportion of infants, indubitably the

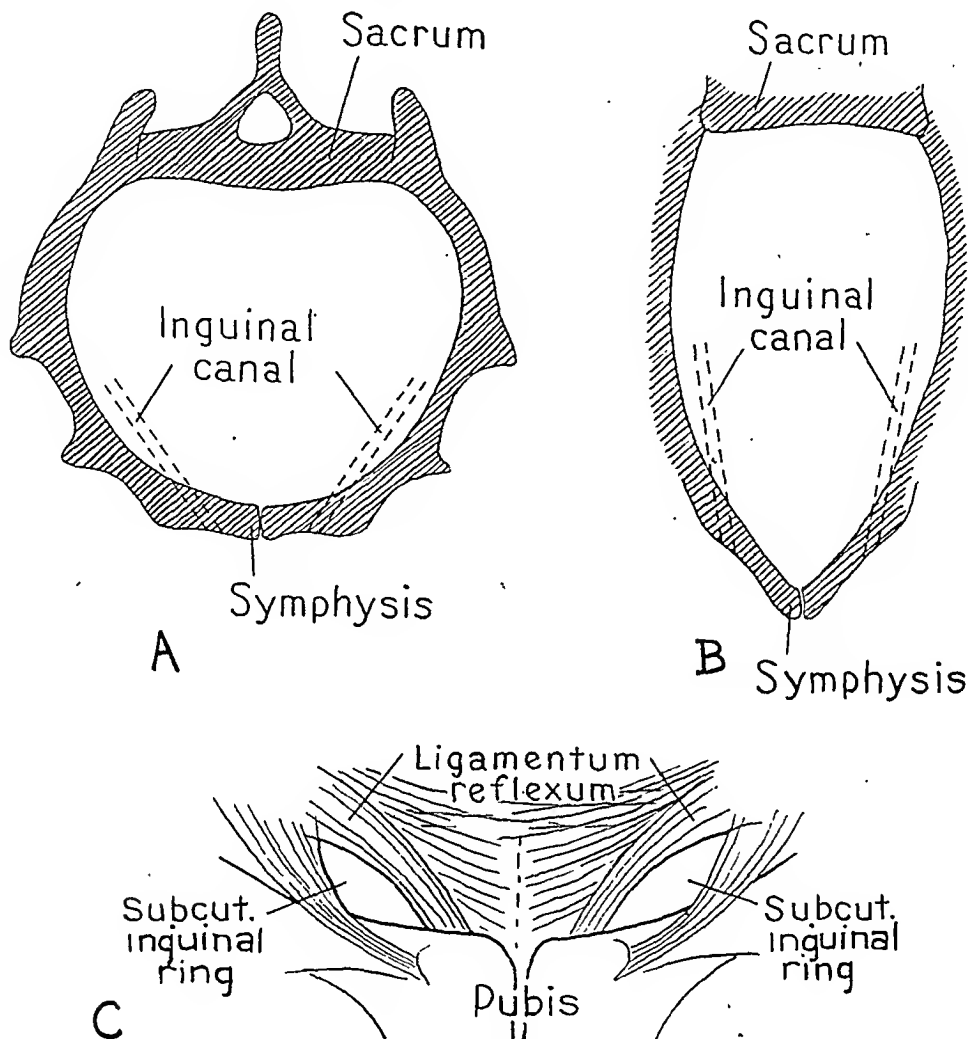


FIG. 1. Man's susceptibility to hernia caused by the orthograde posture is overcome by the visceral support and the obliquity of the inguinal canals. A, the form of pelvis and inguinal canal in man; B, the corresponding forms in pronograde primates (from Keith's Human Embryology and Morphology); C, ligamentum reflexum.

ties, presents not only a short inguinal canal with the anulus inguinalis profundus directly opposite the anulus inguinalis subcutaneous, but also defects due to maldescent of the testis and of non-obliteration, or obliteration in part, of the tunica vaginalis.

**Secondary Etiologic Factors.** Factors which increase intra-abdominal pressure, excessive crying, constipation, straining, phimosis and coughing, are frequent secondary etiologic factors.

closure of the processus vaginalis, incomplete at birth, finally occurs when they are a few months old. During the interval any unusual increase of intra-abdominal pressure favors the development of a congenital inguinal hernia.

#### PATHOLOGY OF INGUINAL HERNIA IN INFANCY AND CHILDHOOD

In infants and older children the vast majority of hernias are of the oblique variety. The minority reveal other varie-

ties, usually with one or more of the following associated conditions: (1) Extroversion of the bladder, complicated by

*Contents of the Hernial Sac.* The small intestine is the most frequent content of the sac. Omental contents are uncommon in

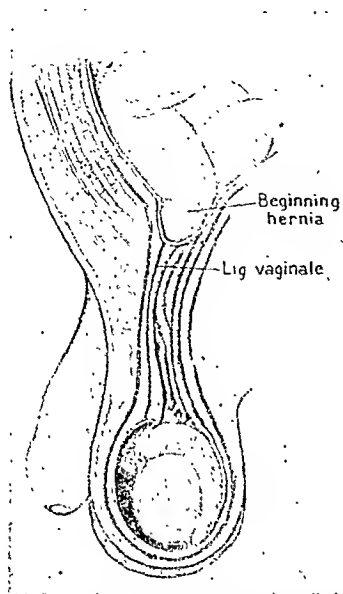


FIG. 2. An early stage in the formation of an indirect inguinal hernia.

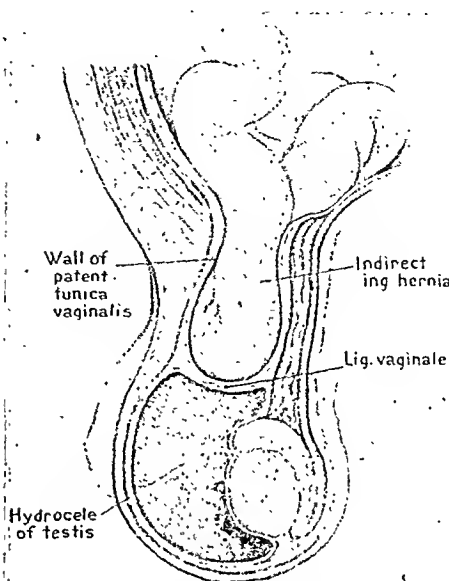


FIG. 3. Indirect inguinal hernia with hydrocele of the testis.

direct inguinal hernia, (2) undescended testis, with an inguinal hernia, in which the sac is proparietal, and (3) ectopia testis, in which the hernial sac may trail the aberrant testis.

*Congenital Inguinal Hernias.* In this variety the hernial sac leaves the abdomen, with the various structures of the spermatic cord, and passes through the abdominal wall along the inguinal canal, appearing on the surface through the subcutaneous ring. In this group are the following sub-groups: (1) Bubonocoele; so-called because the sac is commonly found at the usual site of buboes—an incomplete hernia confined to region of the anulus inguinalis profundus; (2) inguinal; the protrusion is lodged completely or partly within the inguinal canal. The tunica vaginalis of the testis does not communicate with the patent tunica vaginalis of the hernia; (3) scrotal; the hernia passes through the anulus inguinalis subcutaneous and fills part or all of the scrotal sac. There is a continuity of the lumina of both the testicular and cord tunicae.

children because at an early age the omentum has not reached the degree of development which it assumes in later life.

#### COMPONENTS OF INGUINAL HERNIAS AND THEIR RELATIONS

*Relations of an Inguinal Hernia.* The relation of the spermatic cord to the neck of the hernial sac is of prime importance. It usually lies posterior, lateral and below the sac, but it may spread out upon it, the vas deferens being always medial and the vessels lateral. The protrusion sometimes appears to have passed directly through the tissues of the spermatic cord, separating the vas from the vessels. (In direct hernia the cord is not infrequently found spread over the surface of the sac.)

The relations of the testicle to the hernial sac are variable. In acquired hernia it is usually found below and in the congenital, it lies at the lower portion of the sac.

*Components of an Inguinal Hernia.* The components of a complete inguinal hernia are:

- The Sac:* { Mouth; the path between the lumen of the sac and the abdominal cavity.  
 Neck; the narrow section between the mouth and body of the sac.  
 Body; the portion lying beyond the neck.
- The Contents:* { 1. Omentum  
 2. Intestine  
 3. Other viscera or parts thereof  
 4. Fluid  
 5. Various loose bodies

### *The Coverings of the Sac*

*Hernial Coverings and Sac or Sacs.* The immediate covering of the structures contained in the hernia is called the hernial sac.

An oblique inguinal hernia, whether congenital or acquired, possesses the same coverings as the spermatic cord.

A direct inguinal hernia (Hesselbach's hernia), if it finds exit through the medial inguinal fossa between the pliae epigastrica and hypogastrica, pushes ahead its own covering of transversalis fascia, in place of the ready made tunica vaginalis testis et funiculi spermatica. If it egresses through the internal or supravesical fascia between the pliae urachi and hypogastrica, it must protrude in front of it not only the transversalis fascia, but the edge of the tendo conjunctus likewise, the latter taking the place of the cremasteric covering.

The sac lies in the middle of the cord, surrounded by its various coverings, the veins resting on its anterolateral aspect, while the vas deferens with its artery lies on the posteromedian surface.

At the upper extremity of the cord a pedunculated collection of fat is often present, especially in young stout babies. The bladder wall sometimes lies in close relationship with it.

*Disposition of the Sac.* The disposition of the sac in a congenital inguinal hernia may follow one of four courses: (1) the vaginal; (2) the funicular; (3) the retro-

funicular; (4) the intrafunicular. (Figs. 12, 13 and 14.)

*Symptoms.* In certain cases the hernia is noticeable at birth. In the majority, however, the hernia appears during the second or third month. It reduces easily.

The large hernia which contains a quantity of small intestine and possibly the cecum or sigmoid loop is often associated with signs of intestinal derangement.

### DIAGNOSIS

*Physical Examination.* It is important that a definite routine be followed in the examination of every hernia, whether in infancy or later life. Investigation begins with an examination of the testes—whether they are in their normal position—completely descended. Anorchism is extremely rare. The spermatic cord should then be examined. The finger is passed along the whole length of the spermatic cord and it may be possible to delimit the lower end of a funicular sac. (It is usually possible to diagnose the condition without inserting the finger into the inguinal canal.)

The inguinal rings should be examined, if necessary. A patulous ring is suggestive of the presence of a hernia. (Fig. 15.)

*Inspection.* There is rarely much difficulty in making a diagnosis. On gentle pressure from below a reducible swelling will be found which passes from above downward and makes its appearance on the surface through the subcutaneous inguinal ring. It is unlikely to be anything other than a hernia. When it is reduced, the groin should be further examined for possible associated conditions, e.g., inguinal adenitis, iliac adenitis, or hydrocele of the spermatic cord.

If the hernia is incarcerated, a tender mass, flattened, will usually be palpable within the inguinal canal or in the scrotum on the corresponding side. The infant, or an older child, cries continuously and is in evident distress. If the incarceration is of few hours' duration, there is more or less constant vomiting, abdominal distention and borborygmi.

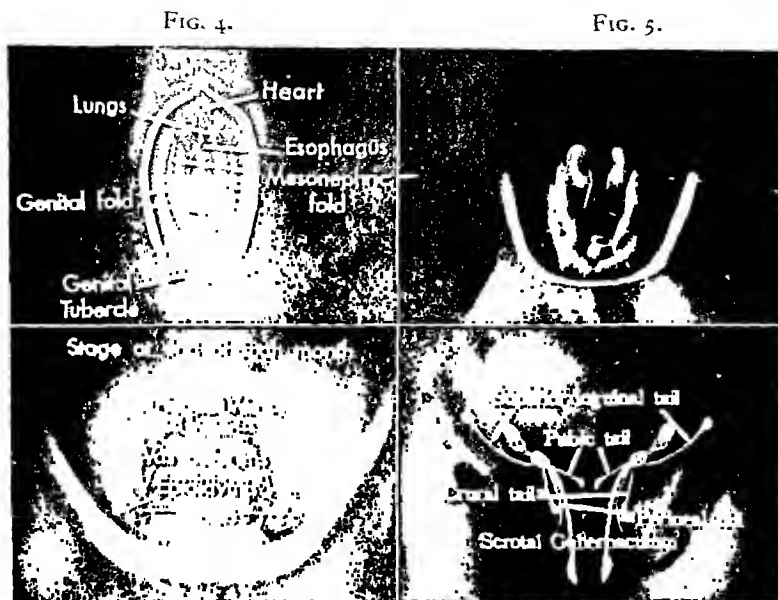


FIG. 4.

FIG. 5.

FIG. 4. Condensation of embryonic mesoderm.

FIG. 5. Anlage of testis; testis beginning to lose its elongated form.

FIG. 6. Testis, globular in form, just before descent through inguinal canal.

FIG. 7. Gubernacula "guiding" the testis to its normal and abnormal habitats.

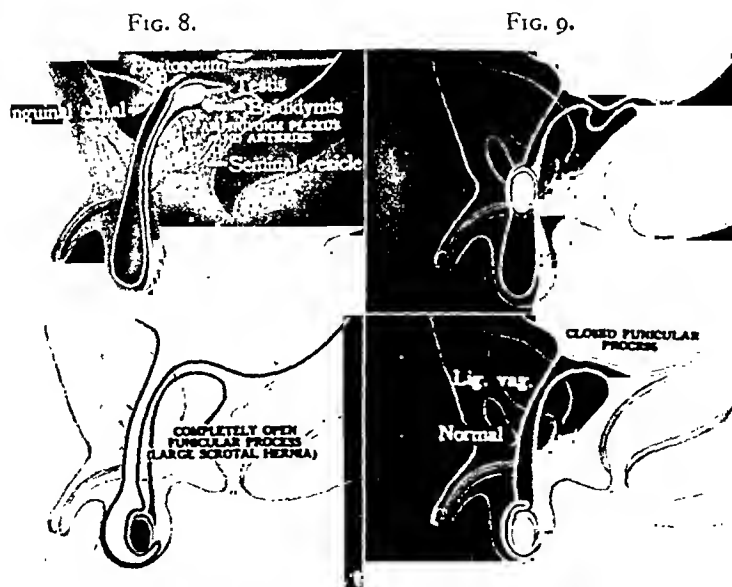


FIG. 8.

FIG. 9.

FIG. 8. Beginning of the descent of the testis showing strong scrotal gubernaculum.

FIG. 9. Testis just below the subcutaneous abdominal ring.

FIG. 10. Failure of agglutination of processus vaginalis, forming a scrotal hernia.

FIG. 11. Testis and scrotum showing normally agglutinated processus vaginalis; ligamentum vaginalis.

## DIFFERENTIAL DIAGNOSIS

There are certain conditions which may offer difficulty in the diagnosis of congenital inguinal hernia. They are:

matic cord and it may be possible to differentiate the latter structure.

3. *Intermittent Hydrocele of the Tunica Vaginalis.* When an ordinary hydrocele is

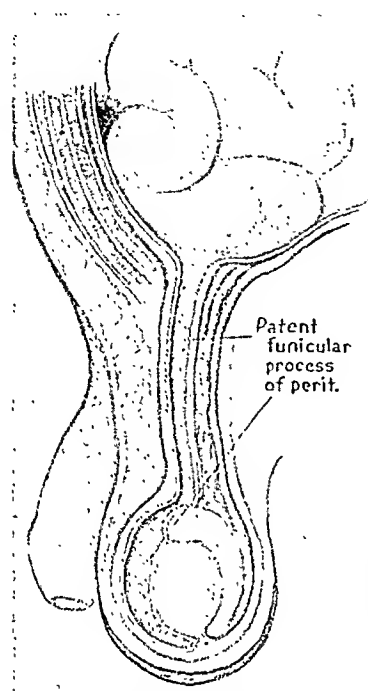


FIG. 12. Failure of closure of the tunica vaginalis, its lumen being continuous with that of the tunica vaginalis of the testis. Eventually this will become a large serotal hernia.

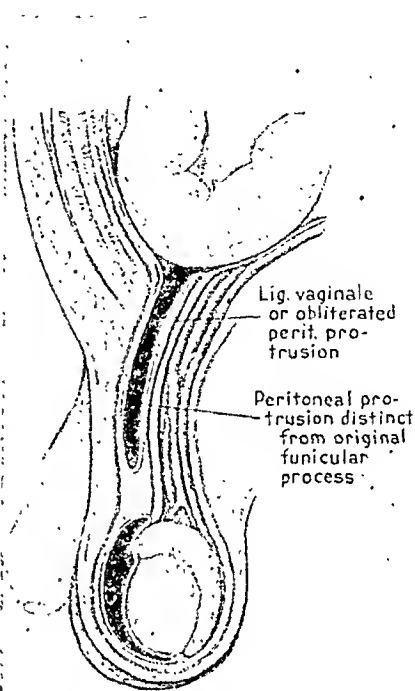


FIG. 13. The funicular process of peritoneum is completely closed by a peritoneal diverticulum which has occurred parallel to the ligamentum vaginale, simulating a congenital indirect inguinal hernia.

1. *Encysted Hydrocele of the Cord.* There is a localized swelling in the line of the spermatic cord, apparently part of it, and irreducible. A hydrocele of the spermatic cord is frequently mistaken for an irreducible hernia. The swelling is irreducible, yet there are no symptoms indicative of irreducibility. The spermatic cord is usually palpable above the upper limit of the swelling. The mass is movable, both in the long axis and across the spermatic cord. Hydrocele of the spermatic cord gives a distinctive palpable sensation. It is tense, smooth and fluctuates. There is no impulse on coughing.

2. *Lipoma of the Cord.* The swelling is always present. There is no impulse on coughing. The mass is media to the sper-

under examination, there is little likelihood of a mistake in diagnosis because the mass rests entirely below the palpating fingers when the spermatic cord is grasped. However, when an intermittent hydrocele is under consideration, in addition to the hydrocele of the tunica vaginalis, there will be found an incomplete closure of the processus vaginalis, the degree of patency being insufficient to permit a hernial protrusion, yet adequate enough to permit fluid to pass from the abdominal cavity into the tunica vaginalis. There is a history of intermittent swelling. On examination the spermatic cord will appear of increased size. Though a thickened cord is palpable, its width is never increased by the contiguous presence of abdominal contents.

The size of the swelling varies from time to time.

4. *Undescended Testis.* The hernial tumor is elastic and painless on pressure,

THE DIFFERENTIAL DIAGNOSIS OF REDUCIBLE INGUINAL HERNIAS AND CONGENITAL HYDROCELES

	Complete Reducible Inguinal Hernia	Congenital Hydrocele
Location.....	Swelling continuous with inguinal region	Same as in an inguinal hernia
Impulse.....	Distinct on coughing	No
Translucency....	Not translucent, as a rule; rarely so in children	Translucent
When reduced...	Gurgling of intestine heard under pressure; reappears rapidly	Reduction and re-appearance slow
Relation to testes and spermatic cord.	Lies above or anterior to testis	As in hernia
Palpation and percussion.	Soft, semi-elastic; dull, if omentum; traumatic, if intestine	Harder and tenser; dull on percussion

THE DIFFERENTIAL DIAGNOSIS OF REDUCIBLE SCROTAL SWELLINGS

	Hernia	Congenital Hydrocele
Age.....	Occurs at all ages	Infancy
Appearance.....	Pyriiform	Pyriiform
Tactile sensation	Soft; semi-elastic	Hard; elastic
Impulse on coughing.	Definite; expansile	Usually absent; slight, if present
Translucency....	Non-translucent in adult; may be translucent in infants	Translucent
Fluctuation.....	None	Present
Percussion.....	Resonant, if intestine; dull, if omentum	Dull
Auscultation....	Gurgling, if intestine is present	Dumb
On reduction by taxis.	Feeling of solid, slipping body	Prolonged period for fluid to be cleared
Change on assuming supine position.	Will not reappear	Will reappear, but slowly

while an undescended testicle is usually firm and tender.

EXTRAPERITONEAL OPERATION FOR REDUCIBLE OBLIQUE INGUINAL HERNIAS IN INFANTS AND CHILDREN

*Male.* Hernias in infancy may be treated by a spring truss or knitting yarn

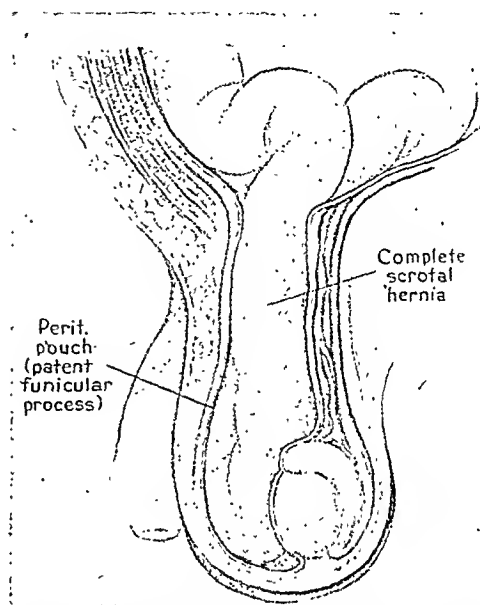


FIG. 14. Complete scrotal hernia wherein the funicular process of peritoneum (tunica vaginalis) is opened to its entire extent.

properly looped. In my opinion, a palpable or visible hernial protrusion is always surgical.

The operation is facilitated if the child is placed in the proper position upon the operating table. The thighs, even under anesthesia, remain slightly flexed upon the pelvis. The malposition is avoided by placing the patient with the buttocks on a sand pillow, and extending the thighs somewhat over the edge of the support. This changed position throws the inguinal rings forward.

*Operation.* The initial incision, one and one-half inches long, is made directly over the inguinal canal parallel to and one-half inch above the inguinal ligament. Its lower extent should be over the anulus inguinalis subcutaneous. The small subcutaneous



superficial epigastric vessels are caught, ligatured and divided.

The aponeurosis of the external oblique

the upper part is separated from the spermatic cord and treated, as is its counterpart in the scrotal varieties of

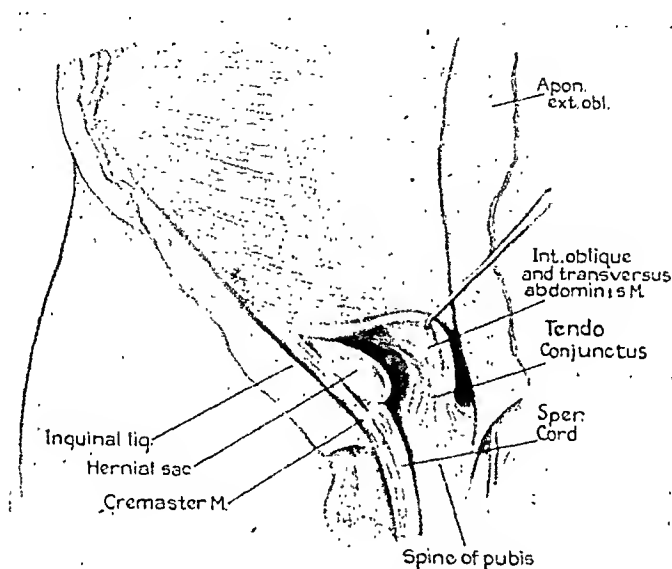


FIG. 15. Sac of indirect inguinal hernia and its relation to the neighboring structures.

muscle comes into view and the anulus inguinalis subcutaneous is identified and brought into clear relief. The aponeurosis itself may be divided over the entire length of the inguinal canal. This facilitates complete removal of the hernial sac, the great desideratum in all hernial operations. This procedure is not always necessary.

The fascial envelopes of the spermatic cord, raised from their bed, are divided; first, the external spermatic and then the cremasteric. The sac, invariably thin, now looms through the internal spermatic fascia. It will be found closely adherent, especially in long-standing cases, to the upper and medial part of the spermatic cord structures. The fascia (together with the vas and veins, which are usually more adherent than the other structures) is now separated by blunt dissection from the sac down to its neck. Great care and extreme patience are often required in this dissection in order to avoid tearing the sac at and in the anulus inguinalis profundus. Such an accident may lead to partial evisceration and shock.

Many surgeons divide the hernial sac;

hernia; with the lower part there is a choice of methods. Some surgeons permit this divided end to drop back unsutured. It is better not to divide the sac, but remove it *in toto*.

If the spermatic cord is put in traction and teased out laterally, the hernial sac can, as a rule, be identified by its translucency and its glistening, grayish-yellow color. Care should be exercised not to injure the ductus deferens, which usually is adherent to the posterior surface of the sac. There is considerable variation in the character of this structure. In the vaginal type, it is always thin and closely adherent to the tissues of the spermatic cord.

The sac may be opened to further identify it as such and to ascertain whether any intra-abdominal viscus, a part thereof, or any associated structure, adherent or free, is confined therein. The usual hernial content is small intestine. The omentum is found less often than in the adult. It is usually unnecessary to open the sac. Palpation and visualization are sufficient safeguards against traumatizing an incarcerated viscus.

It is easier to reduce the contents before the sac is opened. It is often advisable, after inspecting the interior of the sac for adhesions, to insert the index finger and then to brush aside contiguous areolar tissue and the spermatic cord while causing traction on the sac with the finger within. Thus, a high transfixion of the sac may be accomplished. Firm, but non-violent, traction is made upon the sac; the neck, often identifiable by an accompanying pad of yellow, extraperitoneal fat, is transfixed as high as possible and the redundant part of the twisted sac is tied two ways and cut off just above the level of the parietal peritoneum, leaving an adequate stump to retract into the abdominal cavity.

Two or three sutures of No. 1 chromic catgut may sometimes be employed to stitch the internal oblique muscle and the tendo conjunctus to the inguinal ligament superficial to the spermatic cord. This step, however, is not essential. The divided margins of the external oblique aponeurosis are approximated with a few fine chromic catgut sutures. The skin is sutured with black silk. The wound is then covered with gauze saturated with collodion for waterproofing.

#### ACCIDENTS IN INGUINAL HERNIA OPERATIONS

Certain of the following contretemps are occasionally met with in inguinal hernia operations: (1) Injury to the spermatic cord, with the sequelae of thrombosis of the veins and subsequent infarction of the testis; (2) injury to the spermatic artery, with, at times, necrosis or atrophy of the testis; (3) division of the vas deferens; (4) injury to the urinary bladder; (5) injury to the inferior or deep epigastric blood vessels; (6) injury to the external iliac vessels; (7) injury to the intestine, and (8) injury to the omentum.

#### PROGNOSIS

The proportion of cures which should be obtained is approximately as follows:

Recent inguinal hernias in childhood—

oblique inguinal—and in young adults—100 per cent.

#### INGUINAL HERNIA IN FEMALE INFANTS AND OLDER CHILDREN

An inguinal hernia in a female infant is a relatively rare occurrence. The proportional incidence of hernia in male and female children is about 20:1.

*Pathology.* The sac, usually small and pear-shaped, lies on the ventral surface of the round ligament.

The sac-content is frequently an ovary. The hernial sac may also contain oviduct and omentum or intestines. If the hernia is a large or massive one, the body of the uterus, among other structures, may become one of the contents. The author has found this condition in two cases.

*Diagnosis.* In female infants and older children there are three conditions which may simulate inguinal hernia: (1) hydrocele of the canal of Nuck; (2) enlarged inguinal glands, and (3) femoral hernia.

TABLE I

Total Number of Cases.....	150
Sex	
Males.....	138
Females.....	12
Total.....	150
Age	
Under 6 months.....	76
Over 6 months.....	74
Side	
Right.....	71
Left.....	56
Bilateral.....	23
Results	
Cured.....	150

One recurred (?). There was a suggestion of a recurrence in a male infant twelve months old. Further operation is contemplated to determine whether the condition is really a recurrence.

A hydrocele of the canal of Nuck resembles irreducible hernia in which the ovary may be one of the contents of the hernial sac. It may be impossible to differentiate between the two conditions. The hydrocele, however, is often completely irreducible. It is not tender and fluctuates on palpation.

Enlarged inguinal glands may be excluded because of their position and the absence of an associated lesion.

Femoral hernia is differentiated because of its relationship to the spine of the pubis; the neck of the femoral sac lies external to, and at a lower level than, that anatomic landmark.

In principle and technically, the operation for reducible, oblique inguinal hernia in women is the same as that for men, the round ligament being treated in a manner similar to the spermatic cord, or the ligament is sutured to the structures of the inguinal canal. When it is impossible to separate the ligament from the sac, part of it is removed with the sac and the cut ends are approximated and sutured.

The developmental defect causing this variety of hernia in women simulates the normal descent of the testis in the male. The gubernaculum of the ovary (the anlage of the ovarian and round ligaments) become attached to the cornu of the uterus.

This prevents the descent of the ovary into the inguinal canal under normal conditions, despite the fact that the distal end of the gubernaculum is attached to the labium majus, the homologue of the scrotum. A hernia occurs when this mechanism becomes defective. The canal of Nuck (which is analogous to the processus vaginalis in the male) normally becomes obliterated at the end of the eighth intra-uterine month, but may remain patent throughout adult life.

#### SUMMARY

1. Inguinal hernias in infants should be operated upon as soon as the condition is diagnosed.
2. Knowledge of anatomy and embryology is important.
3. Anesthesia may be local or general.
4. The infant may be sent home within a few hours.
5. There should be no recurrences.



# A PEDIATRIC UROLOGICAL PROBLEM IMPORTANT TO THE GENERAL PRACTITIONER \*

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ELKINS, WEST VIRGINIA

IT is my belief that the condition of congenital urethral valves occurring in the infant male has received far too little recognition. Nine out of every ten physicians seem to be entirely unfamiliar with this pathological entity. On the other hand, one cognizant of this condition can readily reach a presumptive diagnosis on the basis of a history and physical examination alone. All too frequently these cases are classified as an enuresis problem and should the usual remedies fail are cast aside as fundamentally a functional or behavior problem.

Primary symptoms depend on the degree of urethral obstruction offered by the valves; the range may vary from slight straining during the act of micturition up to the point of complete retention. As intermediate symptoms one should mention dysuria, a small stream, frequency, nocturia, dribbling and overflow incontinence. The course of events is quite similar to that seen in the prostatic case. Whereas enuresis is a bed-wetting problem occurring only during sleeping hours, the urethral valve presents diurnal urinary difficulties as well. Intermittent costovertebral angle pain appears as a later symptom due to back pressure on the upper tracts. Concomitantly, with the initiation of renal damage and insufficiency leading to uremia, one witnesses the systemic symptoms of the latter condition, namely, anorexia, nausea, vomiting, headaches, weight loss, stunted growth and secondary anemia.

*History.* About 130 cases of this condition have been reported in the literature to date. The fact that over half of these were not discovered till autopsy emphasizes the

high incidence in which this entity passes unrecognized clinically. Langenbeck first described the pathological findings in 1802. Thirty years later Guthrie and Velpeau working independently reported the effects of the urethral obstruction on the upper urinary tracts. Clinically the condition was first recognized by Eigenbrodt in 1891. Thirty-one years ago Knox and Sprunt were the first in this country to describe their findings. Back in 1912, a prominent ridge coursing along the urethral floor between the external sphincter and the verumontanum was witnessed with a cystourethroscope. The following year Young successfully operated on a patient via the suprapubic route. On opening the bladder the vesical neck was found to be dilated and distally two semilunar valves were seen and destroyed by electrocautery.

*Types of Valves.* According to Young's classification urethral valves may be fit into one of three categories: (1) Those arising from the distal portion of the verumontanum; ballooning anteriorly and finally inserting on the lateral urethral walls; (2) those passing like folds of mucous membrane from the posterior part of the verumontanum to the region of the vesical neck; (3) an iris type valve which may occur in any portion of the prostatic urethra.

*Etiology.* Although there are several etiological explanations none will account for all the congenital possibilities. Watson believes the valves are formed *in utero* by a fusion of the colliculus seminalis with the roof of the urethra due to erosion of contiguous surfaces while under continual external pressure. He has several sections

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including a fourteen weeks' fetus showing this fusion. Another explanation is a developmental anomaly with undue promi-

In the latter condition one is fortunate if the lumen can be located with a filiform. The degree of the pathological condition



FIG. 1. A cystogram in the Trendelenburg position showing a cavitated prostatic urethra, a contracted bladder with small diverticula, an incompetent left uretero-vesical valve, a dilated, tortuous left ureter and a fourth degree hydronephrosis.



FIG. 2. A cystogram utilizing the Trendelenburg position showing the amount of reduction in the size of the left upper tract after four weeks' catheter drainage.

nence of the Wolffian and Mullerian ducts at the point where they enter the verumontanum. Other investigators have suggested hypertrophied folds as an etiological basis. Lederer believes the membrane is a remnant arising from the fusion of the entoderm with the ectoderm. The last hypothesis seems most appropriate to explain the iris type valve while Type I and II in Young's classification might be accounted for by any of the other theories.

**Pathology.** Because of the nature of the valves (Type I and II) which are not unlike those of the aorta in principle, a urethral catheter can generally be passed with little or no resistance. Of course, this situation is not found in the case of the iris type valve.

in the bladder and upper tracts is proportional to the amount of obstruction. Some cases have advanced to such an extent *in utero* that death ensues a day or two post-natum. The disorder is quite similar to that seen in urethral obstructions due to such causes as prostatic hypertrophy, urethral stricture and so on.

As the bladder fails entirely to overcome the resistance of the valves, it accumulates a residual urine. Along with continued efforts to evacuate itself, the muscle fibers hypertrophy in groups or bundles giving rise to trabeculation. Concomitantly with the increased bladder pressure that portion of the urethra proximal to the valves becomes dilated. In advanced cases the prostatic urethra is markedly cavitated and appears not unlike the prostatic bed

following an enucleation. Unfortunately, the effects of the back pressure are not limited to the lower tract but are transmitted above and will eventually produce a hydroureter and hydronephrosis. As the ureter dilates its very weight causes it to sag and angulate to the point where it presents a picture of alternate points of constriction and sacculation. Less frequently the uretero-vesical valve will become incompetent. Under these circumstances the entire pressure is transferred to the upper tracts permitting the bladder to remain permanently contracted. The ultimate course will be that of renal insufficiency and a uremic death unless some intercurrent infection should intervene to hasten death.

In addition to the primary bladder symptoms and the secondary effects of renal back pressure the condition of urinary stasis predisposes to secondary infection. With its advent all symptoms are accentuated and accompanied by fever, chills, toxicity and occasionally calculi formation.

**Diagnosis.** Differential diagnosis must exclude hypertrophy of the verumontanum, contracture of the vesical neck, neurogenic bladder, chronic nephritis and polycystic kidney. Besides a good history and physical examination there are other diagnostic methods available such as residual urine determination, panendoscopy, intravenous pyelogram, cystogram, urethrogram and retrograde pyelography. Should the residual urine be large and evidences of chronic backpressure be present it is decidedly inadvisable to decompress completely for the sake of a total residual determination. Occasionally a cystogram, if taken with the patient in the Trendelenburg position, will outline one or both upper tracts. Should the patient be in uremia or in a state of impending uremia, an intravenous pyelogram is of no avail as the renal function is inadequate to concentrate the dye sufficiently for visualization. Passing a panendoscope under direct vision is the most ideal method

of visualizing the primary pathological condition.

**Treatment.** If a catheter passes, the



FIG. 3. A cystogram showing considerable increase in the bladder size as well as the left ureteral stump terminating over the sacroiliac joint. The latter acts as an accessory bladder.

initial treatment should be limited to a gradual release of the upper tract pressure. This step alone may require several weeks. When the patient has reached a stage wherein free drainage may be maintained, it should be continued until the blood urea or non-protein nitrogen maintains a fairly stationary level. Many of the earlier attempts to treat urethral valves failed due to lack of appreciation of this one point.

Valves may be destroyed via the suprapubic route using the scalpel, cold punch or electrocautery as in Young's first case. Later Young achieved good results with the punch resection per urethra. In 1921, Randall satisfactorily treated two patients with a fulgurating electrode through a cysto-urethroscope. Campbell has had equally good results in forty-seven cases of congenital bladder neck obstruction

using his baby resectoscope. Urethral dilatation may be used as a method of therapy but in general because of the nature of the valves, it is not entirely satisfactory.

#### CASE REPORT

No. 48312. O. S. a fifteen-year old boy, was admitted to the Urological Service December 3, 1943. Since infancy he had been afflicted with diurnal dribbling and nocturnal incontinence. Occasionally, his symptoms were accentuated by bilateral loin pain and accompanied by fever and chills. A voluntary effort to void merely produced a more rapid rate of dribble followed by a short period of continence. Five years previously he had had a urogram and was told that nothing could be done for his condition of "infantile bladder." In general his appetite was poor; he tired readily; suffered numerous headaches; was markedly undersize and underweight for his age and showed poor resistance toward upper respiratory infections. He had had no other serious illnesses or operations in the past.

His temperature was 99.2°F., pulse 96 and respirations 20. Physical examination revealed a sallow complexioned boy who was underdeveloped, poorly nourished and obviously chronically ill. The head was normal. The heart was slightly enlarged to the left; the sounds were of good quality with regular sinus rhythm and no murmurs. Blood pressure was 170/130. The lung fields were clear. Both kidneys were enlarged and tender; a tender mass also was felt suprapubically to the left of the mid-line. The genitalia were those of a normal male; the prostate was small, smooth, non-tender and fluctant. Reflexes were physiological.

The admission urine was amber clear, alkaline, specific gravity 1.006, sugar free, trace of albumen and microscopically negative. The hemoglobin was 70 per cent; erythrocytes 3,700,000; leucocytes 8,000; 80 per cent polymorphonucleocytes and 20 per cent lymphocytes. Blood urea nitrogen was 58.3 mg. per cent; blood calcium 11.8 mg. per cent; Kahn test negative.

The initial treatment consisted of the passage of a No. 18 French catheter and a regime of withdrawing 100 cc. of urine every two hours. Free drainage was not possible for several days due to severe suprapubic pain whenever a certain minimum pressure level was reached.

A flat plate of the abdomen showed tre-

mendous enlargement of the renal shadows but no calculi or obliteration of the psoas borders. Diodrast given intravenously was seen on the right side after forty minutes; none was seen on the left up to two hours. The calyces of the right kidney were enlarged and blunted; the pelvis was dilated to a second degree hydronephrosis. The bladder was not visualized. After the third day of drainage a cystogram was taken with the patient in the Trendelenburg position using 300 cc. of a 3 per cent sodium iodide solution. (Fig. 1.) This procedure due to an incompetent left ureterovesical valve or sphincter showed a fourth degree hydronephrosis, a markedly dilated and tortuous ureter, a contracted bladder with small diverticula and a cavitated proximal urethra. No reflux occurred up the right side.

After twelve days' drainage the blood pressure dropped to 154/102 and the blood urea to 37.5 mg per cent. At this time under general anesthesia the urethra was dilated to a No. 26 French sound but not without meeting some resistance in the bulbous and prostatic urethral regions. The sound was followed by a No. 24 French Brown-Buerger scope which revealed prominent trabeculation of the bladder wall. The right ureteral orifice was natural; the left dilated to approximately 1.5 cm. The prostatic urethra was cavitated down to the mid-portion of the verumontanum suggesting a Type 1 urethral valve after Young's classification. Ultimately the urea nitrogen reached a relatively stationary level at 40 mg. per cent and the blood pressure was recorded as low as 126/80. At this time, although the patient had a fair size stream, he could only void about an ounce at a time as the bladder collecting capacity was largely assumed by the dilated left upper tract. Since the left kidney was a non-functioning sac a nephrectomy was advised with the hope that the elimination of this accessory bladder so to speak would increase the intravesical tension and possibly aid in re-establishing normal bladder function.

After four weeks' catheter drainage (Fig. 2) a left nephrectomy was performed under drop ether using the classical twelfth subcostal, muscle-sectioning, retroperitoneal approach. The nephrotic sac and the dilated ureter was removed down to the approximate level of the pelvic brim. The wound was closed in layers about a Penrose drain. The postoperative course was uneventful.

Two weeks postoperatively a cystogram in the Trendelenburg position showed little change in the bladder size and a small amount of reflux up the left ureteral stump. The ureteral catheter was removed and the urethra dilated to No. 26 French sound. At the time of discharge four days later the patient was voiding a good size stream at hourly intervals. The urine was hazy, specific gravity 1.008, albumen a trace and a moderate number of pus cells present per high power field. The blood urea nitrogen was recorded at 32 mg. per cent.

One month after discharge the boy was readmitted for a check-up. At this visit he was voiding approximately 200 cc. of slightly hazy urine every two hours. The urine never concentrated above 1.008 and always revealed a trace of albumen. The blood pressure was 146/106 and the urea nitrogen 30 mg. per cent. The bladder showed very little effort to re-expand and the ureteral stump was still acting as an accessory bladder. The urethra was dilated to a No. 27 French sound.

On his most recent check-up (six months postoperatively) this boy was asymptomatic. His cheeks had regained a healthy color; he had gained fourteen pounds in weight; the interval between voiding had increased to three hours, the quantity to 300 cc. A cystogram showed considerable increase in the bladder size with the left ureteral stump still acting as an accessory bladder. (Fig. 3.) The blood pressure remained around 158/108 and the urine showed a few pus cells per high power field.

#### SUMMARY

Any male child with a persistent urinary problem which fails to respond to the usually enuresis regimes in a reasonable period of time should not be cast aside as a behavior problem but should be given the benefit of a urological investigation. The fact that over half of the 130 cases of urethral valve reported in the literature were not diagnosed ante-mortem emphasizes the fact that this pathological entity is not as widely known as it should be. In general the symptoms are diurnal as well as nocturnal and not unlike the course of events seen in the elderly male with obstructive prostatic hypertrophy. The rapidity of renal destruction depends di-

rectly upon the degree of urethral obstruction. The etiology is not clear-cut; the anatomical structure generally conforms to one of the three types described by Young. The history and physical findings will often make the diagnosis whereas cystopyelography and panendoscopy will definitely confirm it. Rapid decompression is to be discouraged. The valves may be destroyed either transvesically or endoscopically using either a cutting current or a cold punch. The prognosis depends on the amount of renal damage done prior to diagnosis, the preoperative care and the operative and postoperative management.

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When strictures of the urethra cannot be treated by dilatation, or when quick results are desirable, internal urethrotomy is indicated. This operation is not to be attempted when an instrument cannot be passed through the stricture.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# PRIMARY OMENTAL TORSION\*

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CLOSED within the parietal peritoneum lie the abdominal and pelvic organs, solid and hollow viscera, each heir and liable to the various pathologic processes of biology: inflammation, degeneration, embryonic dysplasia, and neoplasm. According to the extent of visceral peritoneal covering, these various viscera are fixed (sessile), or else pedunculated or moveable by reason of a mesentery. This latter group of organs, because of their inherent moveability are susceptible to a physical hazard to which its sessile neighbors are not exposed, namely, torsion.

Torsion is defined as twisting. Torsion as it is applied to abdominal organs or tumors implies the rotation of whole or part of the affected structure upon itself, with the formation of a narrowed neck or pedicle, where the circulation to the distal mass becomes constricted. In order to warrant clinical notice, such twisting must cause some degree of circulatory obstruction, since it is axiomatic that any process which produces neither subjective symptoms nor objective (circulatory) changes is purely physiologic and does not justify the category of a pathologic entity. This qualification becomes necessary lest our discussion and classification become confused and encumbered with polynoms and epinoms ("partial," "incomplete," "temporary," etc.).<sup>69</sup>

Perhaps the most familiar examples of torsion are those associated with cystic and solid tumors of the ovary and pedunculated subserous fibroids, where the presence

of a long thin pedicle provides an ideal physical condition for the inception of an axial twist. Torsion of the spleen,<sup>95</sup> the testicle, and the appendices epiploica<sup>22,93</sup> are not uncommon. Torsion of the gall-bladder,<sup>49</sup> cecum,<sup>83</sup> fallopian tube,<sup>100</sup> and lesser omentum<sup>39</sup> are rare. Besides a variety of tumors, any abdominal organ except the liver may undergo rotation.<sup>9</sup>

Torsion in the alimentary tract presents its own peculiar pathologic problem, since twisting sufficient to cause some circulatory embarrassment must simultaneously restrict or occlude the normal flow of intestinal contents. Clinically, this is intestinal obstruction, and when it is produced by this mechanism it is known as "volvulus." The application of the term "omentalvolvulus" to omental torsion by various authors,<sup>53,92</sup> however euphonic, is a misnomer.

It is our purpose in this communication to focus attention on torsion as it occurs in the great or gastrocolic omentum. Until recently, medical teaching and surgical textbooks ignored the subject entirely or mentioned it lightly in passing. With the turn of the century there came a rapid accumulation of reports and reviews on this entity, and its subsequent insertion in references and standard teaching texts. In the light of increasing numbers of case reports from all corners of the earth, torsion of the omentum cannot be regarded as a rare clinical occurrence. Omental torsion is one of the uncommon causes of acute abdominal crises of obscure etiology,

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demanding differentiation from other familiar and uncommon intra-abdominal lesions.

It is our contention that it is a clinical condition which still suffers unwarranted neglect in surgical teaching and consideration of the differential diagnosis of the acute abdomen. Omental torsion is hardly ever thought of or mentioned as a cause for vague abdominal pain. Lest this indictment of general surgical acumen be lightly dismissed, we make this plea for a review of the entire subject, so that opinion as to its relative surgical importance may be judiciously rendered.

Since all the early cases of omental torsion reported<sup>2,73,23</sup> were associated with a right inguinal hernia, this concurrence was considered an essential combination until 1899, when Eitel<sup>30</sup> reported the first case of intra-abdominal torsion occurring independent of the presence of an inguinal hernia. Scudder,<sup>87</sup> in 1904, claimed that his was the first case of primary torsion to be reported, but Baldwin<sup>5</sup> and Syme<sup>97</sup> had each reported a case in 1902.

Following Eitel's report, it became evident that omental torsion need not be accompanied by a hernia, and a division into hernial and abdominal types evolved. Upon its basis, there has mushroomed a top-heavy, unwieldy classification. A number of varieties of omental torsion must be recognized, but far too many sub-divisions have been advanced and advocated, and the stage has been reached where the same term possesses a different meaning in another's classification.

In rare and uncommon affections, particularly when they are not well understood, there is a tendency to elaborate a complex classification in an attempt to provide a category covering any observed or postulated variety, thereby defeating the prime purpose of classification. The sole object of medical classification is to express by arrangement and nomenclature the essence of variety in fundamental phenomena, in order to facilitate recognition, understanding, teaching, and transmission

of ideas. The surgeon must accept only a subdivision so simple and inclusive that it is part of his regular mental equipment, ready for instant service during physical examination, discussion, and operation. In this way, all the participants may comprehend distinctions without recourse to texts and references.

Despite the differences in terminology and grouping of sub-types, every previous classification recognized the premise that all cases of omental torsion may be divided into two main etiologic types: (1) Those without apparent cause (idiopathic, cryptogenic, or primary abdominal); and (2) Those associated with or complicated by any pathological condition (secondary) either within the abdominal cavity, or without (hernial, external). Once this fundamental differentiation is recognized, several categories suggest themselves, and any form of pertinent variation may be catalogued. We propose the following simple classification as sufficiently broad to embrace all the reported types:

- A. Primary (idiopathic, cryptogenic, pure intra-abdominal)
- B. Secondary
  - 1. Hernial (external)
  - 2. Abdominal
    - a) Intrinsic (i.e. cysts & tumors of the omentum)
    - b) Extrinsic (pathology of the abdominal & pelvic organs, and peritoneum).

Several authors (Smythe,<sup>90</sup> Hedley<sup>41</sup> and Mesa<sup>64</sup>) reported cases of pure intra-abdominal omental torsion, in which a right inguinal hernia was present, but claimed that this latter co-incidence was without etiologic significance. Clinical experience has taught us that a hernial mass will frequently reduce itself spontaneously, the sac being found empty on operation. The co-existence of a right inguinal hernia with a case of primary omental torsion is too significant to be coincidental, and its hernial onset must be assumed. There is no need to add a "combined" form to the classification (Morris<sup>69</sup>).

When Corner and Pincus<sup>17</sup> tabulated all the cases reported up to 1905, forty-eight of the fifty-four were of the hernial type, almost 90 per cent. In 1928, Morris<sup>69</sup> published a comprehensive review of the entire subject, listing 161 cases from literature (three cases have been deducted from his total, since they are "incomplete" and do not meet the criteria of pathologic torsion), eighty, or 50 per cent were hernial. Lipsett<sup>58</sup> (1941) added eighteen additional cases from the literature up to 1937, only 12 per cent of which were hernial. This rapid decline in the relative frequency of hernial type reported might be variously interpreted, and we offer the following hypothesis: First, with improved surgical diagnostics and operative technic, a certain percentage of cases of hernia (however small) which might have developed omental torsion undergo surgical repair before the omentum reaches the sac, while in those cases in which the omentum does descend into the sac it is released by surgery rather than by "taxis," which maneuver might very well have imparted the precipitating force for the onset of an axial twist. Secondly, numerous cases of the hernial type encountered may have been considered too common to warrant a case report.

Once the subject of omental torsion has been explored, interest tends to concentrate upon the primary type, in view of its relative infrequency, curiosity as to its cryptogenic origin, and speculation as to its preoperative diagnosability. McWhorter<sup>63</sup> had compiled twenty-eight cases of this type from the literature up to 1928. In 1930, D'Errico<sup>24</sup> devoted his entire article to this type alone, giving an abstract of each of the thirty-nine cases reported. Andrews<sup>4</sup> brought the total of the primary type to fifty-four in 1938. In view of the existing world-wide hostilities, medical literature is in a chaotic state, and no estimation of the number is, or should be attempted, in deference to accuracy.

The clinical importance of primary omental torsion depends directly upon the great omentum. Since the other char-

acters in the abdominal theatre attract more attention, the omentum is often viewed out of focus, and this lack of perspective leads to the uncritical impression "the great or gastrocolic omentum has never played a prominent part in clinical surgery, its rôle generally being accepted rather as an inert structure with a function more or less vague and a relationship to clinical symptoms too remote to merit serious consideration" (introduction, Morris<sup>69</sup>). This relegation to an unspectacular part does not restrict its repertoire, since the omentum is supposed to take some part, however small, in a supporting rôle of most of the abdominal tragedies.

In order that we might better appreciate its actual importance, we present herewith the great omentum, the lead in the production (mechanism) of primary omental torsion, prefacing an introduction (embryology and phylogeny) to its character (histology and anatomy) in health (physiology) and disease (surgical pathology). Celcus is credited<sup>46</sup> with first using the term "omentum," but its derivation is obscure, being variously attributed to "operit" (to cover, i.e., the intestines), "opimus" (fat), and "omen," since the haruspices made prognostications from it.

#### THE OMENTUM

*Embryology.*<sup>44,59</sup> The embryology of the omentum is directly dependent upon the development of the stomach. The anlage of the stomach can be recognized in human embryos of 4 mm. to 5 mm. as a laterally flattened fusiform enlargement of the foregut, suspended from the roof of the celomic cavity by part of the common dorsal mesentery known as the mesogastrium. Dilatation of the embryonic stomach goes on more rapidly on the dorsal than on the ventral side, thus producing the greater and lesser curvature, respectively. Beginning in embryos of 12 to 14 mm. the stomach undergoes a rotation on an axis in two planes, producing an

approximate transverse position, with the cardiac (cephalic) end on the left, the pyloric (caudal) end on the right, the lesser curvature facing upward, and the greater curvature directed downward. During this complicated maneuver, the greater curvature carries along the dorsal mesogastrium, converting it into a double fold, like a pouch, containing two layers of flattened endothelium. As the omentum descends, the transverse colon is ascending to its adult position, so that after the fourth month of fetal life the posterior layer of the omentum lies over and adheres to the transverse mesocolon. No actual fusion of elements takes place, and this physiologic adhesion may be separated, since the omental circulation is derived from the epiploic vessels of the greater curvature, and never anastomosis with the mesenteric circulation of the transverse colon. The boundaries of the omental bursa are now complete, and it has assumed its permanent position. At birth, the omental pouch may still be inflated through the foramen of Winslow, but an agglutination of these layers begins soon after birth, obliterating the omental pouch.

*Comparative Anatomy.* Philogenetically, the first indication of an omentum is seen in the lowest forms of vertebrates (the giant salamander). Heusner<sup>47</sup> regards this as a higher stage of evolution, since the omentum is absent in fish. To a certain extent, omental development seems to be determined by an animal's habits and stage of evolution. Thus, birds have only a very primitive omentum. In certain herbivorous animals, in which the excessively enormous size of the stomach (60 to 80 pounds) would readily lead to volvulus of that organ, the omentum serves to stabilize it by sheer weight and by its fixation to the ventral abdominal wall below. In the hibernating mammals, a deposition of excess fat in the omentum during the season of plenty and satiety, serves not only as a storehouse but also an insulating blanket in the lean, cold days of hibernation. In the quadruped, the

omentum is a labile cushion interposed between the mobile visceral peritoneum and the immobile parietal peritoneum, lying in the dependent portion of the abdominal cavity, and indirectly bearing much of the weight of the viscera. In the course of philogenetic evolution, the assumption of an upright posture led to anatomical alteration of the abdominal organs (including the omentum) in readjustment to the pull of gravity. The adhesion to the transverse mesocolon described under embryology, occurs only in man and certain of the erect primates.

*Histology and Anatomy.*<sup>86</sup> The great omentum consists of a double sheet of flattened endothelium, between which run the epiploic vessels, lymphatics, and nerves, enmeshed in areolar tissue with a variable amount of fat distributed in its meshes. It is a highly vascular organ. It becomes a composite four-layered structure by hanging in a double fold, sling-like, from the greater curvature and the transverse colon; like a curtain attempting to shield the intestines from sight. The curtain-like structure lends itself to the formation of folds and tongues, which may normally extend between the intestinal coils. The attachment of the right border to the pylorus varies, and it may sometimes extend over to the duodenum, and even to the gallbladder. Aberrant attachments in this area are the frequent cause of alimentary derangement.<sup>28</sup> The left border forms the ligament to the spleen, and fixes it to the stomach.

The shape, the size, the weight, and the position of the omentum show marked variability; even in the absence of any intra-abdominal disorder. One side, usually the right, may be found longer than the other. It may possess two or more tongue-like processes, have accessory omenta attached to the main organ, or may have processes similar to appendices epiploicae hanging from its free margin. It may be found concentrated in any quadrant of the abdomen. Its length varies from a mere vestige to an enormously elongated mass

reaching into the pelvis. In fat individuals it may attain huge proportion and weight. In emaciated persons as a rule, the omentum is found to be very thin, devoid of fat, and sometimes shriveled to a mere shred.

Concomitant with senile changes and also in those persons in whom the loss of a large amount of adipose tissue has occurred, the transverse colon has a "V" or "U" shape, and in those individuals in whom the stomach is ptosed or distended, practically the entire omentum may occupy the pelvis. When the colon is markedly dilated, as in obstruction or meteorism, the omentum is found high up in the abdomen, often rolled around the posterior aspect of the colon. In the presence of ascites the omentum is invariably found coiled up, and lying along the upper or lower border of the transverse colon, or against the stomach. In cases in which the abdomen contains very large quantities of fluid, the omentum may be found lying on the anterior surface of the liver, and in rare instances it is found floating upon the fluid.

*Physiology.* The omentum is not a vital physiologic organ. It may be congenitally absent<sup>45</sup> and it may be totally removed without appreciable discomfort or disturbance to the individual.<sup>28,46</sup> However, posterity has endowed the great omentum with an extravagant reputation for virtues and capacities. Sown promiscuously, many of these fertile misconceptions flourished to be reaped periodically by certain reviewers (Browman,<sup>12</sup> Heusner,<sup>47</sup> Rubin<sup>86</sup>) and to which we add a crop of our own gleanings.

The ancient anatomists regarded it from a utilitarian aspect. Aristotle thought it blanketed the abdominal organs against cooling. Galen, who filled the omental bursa with water to examine it better, agreed with this view. Vesalius described the omentum as a ligament for the fixation of the transverse colon. Verbojen gave it the capacity to protect the intestines from friction. Hansen believed that it

facilitated respiration by drawing the filled stomach downward.

Experimental physiology revealed that the "moistening" power of the peritoneum was really the property of producing an exudate, while the introduction of foreign particles into the peritoneal cavity demonstrated a marked capacity of the omentum for absorption. Heger<sup>42</sup> likened the omentum to a washrag which cleaned out the abdominal cavity.

Hektoen and Reisman<sup>43</sup> regarded it as a sort of nervous heart in the abdominal cavity, which keeps up an imperfect form of circulation, serving to transude plasma or lymph into the cavity and absorb what is already there. Tait<sup>98</sup> called it the "arbiter of peritoneal tides," Draper and Johnson<sup>28</sup> who described the omentum in the quadruped, as "the bilge-pump of the peritoneal cavity," question this power in the human, pointing out that in the quadruped, the omentum occupies the most dependent part, to which all foreign matter, exudates, etc., will gravitate. This selectivity of the omentum for absorption is decreased with the assumption of an erect posture. The pelvic peritoneum, which has now become the gravitational cesspool, has undergone histologic modification of increased vascularity and lymphatic drainage, hence the use of Fowler's position for intra-abdominal inflammation.

The vascularity and rich lymphatics of the omentum suggested protective properties as an expanded hemolymph organ within the abdomen. Albrecht<sup>3</sup> likened its ability to that of a giant leucocyte whose potentiality is evident with the onset of an inflammatory process. Pirone<sup>77</sup> demonstrated the phagocytic efficiency of its transformed endothelial cells. Goldschmidt and Schloss<sup>37</sup> elaborated on a bactericidal function, which Roger<sup>84</sup> had demonstrated by experiment.

The variability of the position, conformation, and visceral relations of the omentum as discovered at laparotomy and necropsy led observers to attribute to

it some inherent migratory power. Cornil and Carnot<sup>18</sup> described this spontaneous motion as "intelligent." Milian<sup>65</sup> ascribed the activity to "positive and negative chemotaxis," or "intelligent chemotaxis." The belief that the omentum possesses this inherent motility, or that it might move in response to a stimulus, is an impression shared by a majority of clinicians and surgeons. This presumption is the result of credence given to dogma, since "almost all students are informed that the omentum is 'the great protector of the abdomen' which, by some strange inherent power seeks out and tries to arrest trouble."<sup>85</sup> The foremost protagonist of intrinsic mobility, Rutherford Morison,<sup>68</sup> was the first to use that universal metaphor "the abdominal policeman" in teaching his classes. He likened omental movements to that of a jelly-fish. He believed that there could be no doubt that "it travels about in the abdomen with considerable rapidity, and is attracted by some sort of information to neighborhoods in which mischief is brewing." That the omentum is indeed capricious in its response to such calls of duty has been frequently observed at laparotomy and necropsy, and the absence of any intrinsic migratory power has been repeatedly demonstrated by experiment. Fagge<sup>32</sup> has remarked that "the factors which induce the purposeful migration of this 'abdominal policeman' to different parts of the peritoneal cavity constitute a problem which cannot escape the curiosity of every surgeon, yet, so far as I can discover, no one has supplied a logical answer to it."

It will be recalled that, except for a small amount of smooth muscle in the arterial walls, the omentum is entirely devoid of muscle. Nevertheless, it will be difficult to dispel the mirage of omental mobility from current common credulousness. Those authorities who have performed controlled experiments agree with Wilkie<sup>103</sup> and conclude that "there is absolutely no motion." Draper and Johnston<sup>23</sup> concluded that "it is devoid of all auto-

motive power" and "its migration is as much accidental as selective." Rothenberg and Rosenblatt<sup>85</sup> who recently reported their observations on omental mobility under fluoroscopy (an experiment previously performed by Heger) came to the conclusion that the "omentum is moved passively by exaggerated peristaltic activity of the underlying coils of bowel." The investigations of numerous observers is epitomized in an exhaustive study by Rubin.<sup>86</sup> Having reviewed the pertinent literature, he recorded a large series of observations made at cadaver, postmortem, and operation, and repeated under controlled conditions a variety of experiments previously performed by others. From critical evaluation of accumulated objective evidence, he reached the following conclusions: First, the omentum has no spontaneous mobility. Displacements may be explained by (1) intestinal peristalsis; (2) intra-abdominal tension; (3) static condition of the stomach, colon, and small intestines; (4) anatomic relationship to gallbladder and spleen. There is no demonstrable "chemotaxis," such as may bring the omentum up against gravity. This is the result of intraperitoneal fluid or gas, plus the suction action of the diaphragm.

Second, the omentum is not a superior organ with peculiar protective properties. Its usefulness in inflammatory lesions of the abdomen depends upon (1) its power to form adhesions which isolate and render toxic products innocuous; and (2) its power of absorbing and eliminating toxic products or destroying them by virtue of its phagocytic elements. Such protection as it apparently displays is simply due to its properties as peritoneum. As a peritoneal fold, it also assumes the mechanical function of a mesentery: the fixation of viscera and the transmission of a vascular supply.

*Mechanism of Omental Torsion.* The reason why abdominal organs and tumors undergo torsion is not well understood. Several theories exploring the etiology have been advanced, but few are worthy of

mention. Most of them, when reduced by analysis to a basic premise, dispose of the problem simply by comparing the structure to a moving wheel, where the outer rim travels further and faster than the hub. This is equivalent to the *ipso facto* statement that masses undergo torsion because they turn, without consideration of physical principles.

Expressed in mechanical terms, rotation is brought about either (1) by the action of a couple consisting of two forces which are equal, parallel and opposite, or else (2) of one force and a reaction which is a resistance operating in an opposite direction.<sup>32</sup> During axial rotation there is present at the site of torsion a resistant force, the "modulus of rigidity," which is directly proportionate to the actual and relative diameter of the neck or pedicle. This resistance increases enormously as the twists increase and become tighter. Having defined the dynamics involved, let us now consider the anatomic and physical factors which predispose to, or provide the "soil" for omental torsion.

First, there must exist "the absence of mechanical obstacles to rotation." The mass must be freely turnable, in a space and surroundings that will permit twisting. The mass should be smooth, of moderate size, and have an eccentric weight distribution. Such a mass in the peripheral omentum occurs frequently as a tumor or cyst, an inflammatory "ball," or a localized fat hypertrophy. Obesity, which is synonymous with the finding of fat hypertrophy, has been almost a constant finding in cases of primary omental torsion, while it also provides a relaxation of the abdominal wall sufficient for rotation.

Second, a long thin pedicle must exist. This may be present as a congenital or anatomic variation, or acquired either by the descent of a piece of the omentum into a hernial sac, or by the constant traction exerted by a relatively heavy distal part, especially in a dependent organ such as the omentum. Having specified the ideal mechanical "soil," let us now consider several

possible precipitating physical forces, or "seed" for the production of omental torsion:

1. The application of external forces, including trauma, violent exercises, and other body movements: It is entirely probable that the maneuver of taxis, in reducing an omental herniation, can impart an axial twist to the hernial mass as it slips through the smooth funicular channel of the inguinal canal. The large percentage of cases coincident with inguinal hernia bears out this probability. The view that bodily movements might induce rotation is widely supported, under the mechanical principle that the distal mass continues the movement of turning even after the whole body has come to rest, because of the phenomenon of inertia. Bland-Sutton<sup>9</sup> is the authority for the statement that "a tumor hanging freely in the belly should, by mere alteration of the position of the body, or by motion imparted to it by a tumult of the bowels, spin around and twist its pedicle." Trauma<sup>93,63,30</sup> (blows, falls), lifting,<sup>63,52,70,71</sup> or violent exercise<sup>79</sup> have each been noted in conjunction with case reports, but there is no apparent mechanical basis for this association. Hertzler<sup>45</sup> aptly attributed "movements such as reaching across the table for more" as an etiologic factor, qualifying that "obviously it is the habitual reaching and not the individual act which is significant, that is to say, the patients habitually overeat."

2. Peristalsis: Peristalsis offers the most plausible postulate for the impetus to torsion. The passive omentum is constantly being tossed and rolled about, so that any local condensation or mass, especially at or near the free border, will repeatedly turn and untwist itself according to the pattern of peristaltic peregrinations. It must be understood that this force is not an isolated unusual incident that can precipitate torsion, but a constant repeated process. It is suggested by Fagge<sup>32</sup> that the required couple of forces for the rotation of an omental mass is provided when the mass intervenes between two adjacent coils of



intestine, or an intestinal coil on one side, plus the uterus or a lax abdominal wall on the other side, with a peristaltic wave as the motive force. Having come to this conclusion, Fagge<sup>32</sup> reflects that "if intestinal movements can produce omental torsion, why is it not more frequent?" The answer is obvious. The constant recurring tortious force involved must definitely exceed the modulus of rigidity and any other resistant forces to turning. This resistance and reaction to twisting tends to decrease as the physical conditions approach the ideal mechanical "soil" as previously described. When the balance of power favors the tortious forces, rotation is instituted. However, this superiority of force must be continued, since any slight advantage may soon be overcome. Olshausen presents clinical evidence that twisted pedicles frequently untwist spontaneously, and Morris<sup>63</sup> classified as "incomplete" those cases of omental torsion which had undergone spontaneous recovery.

3. The hemodynamic theory: This theory, as first advanced by Payr,<sup>73</sup> is a truly ingenious hypothesis. It depends on the anatomical fact that the veins are larger, longer, and more tortuous than the accompanying artery, and their walls are more easily compressible. Any physical change (kinking or twisting) will impede the venous circulation, and the veins will quickly become engorged. The artery, attempting to propel the blood against an increase in pressure, becomes a tense cord, like the string of a bow, about which the engorged, tortuous plexus of veins, attempting to accommodate themselves, wind around like a spiral. The tissue involved in this process of vascular dynamics must perforce follow its rotating vascular component, and thereby the whole mass undergoes torsion. Any degree of twisting compresses the venous return still further, perpetuating the insidious process. The added blood volume and the stasis in the twisted mass leads to edema, increasing the relative size and weight, which further predisposes to torsion. This vicious cycle

can be broken only when the modulus of rigidity, which is increasing geometrically, catches up to and exceeds the torting forces.

Payr later published<sup>76</sup> a series of experiments endeavoring to prove that the cause of rotation was the change of pressure within the vascular system, especially the vein. Fagge<sup>32</sup> insisted that these conditions do not exist in the pedicle of a rotated mass, since both artery and veins are twisted. He pointed to the work of Adams,<sup>1</sup> who demonstrated that forces are set up which counteract the twisting couple when fluid under pressure is perfused through a twisted tube. This is illustrated in the untwisting and unkinking of the common garden hose during watering. Applying these dynamics to living structures, the pressure in the artery of the pedicle opposes forces which tend to twist it, and is, therefore, another natural protection against torsion. Fagge also points out that hemodynamics presupposes the existence of venous obstruction, which occurs only when rotation has already begun. However, the evolutionary assumption of an upright posture would expose the omentum, now a dependent structure, to the risk of venous congestion.<sup>28</sup> We might suggest the possibility that intestinal peristalsis could provide sufficient twisting of an omental mass under proper conditions for the institution of vascular dynamics.

*Surgical Pathology.* Either the whole omentum, or, more usually, only a portion (generally the right side) may undergo torsion. The direction of turning is clockwise,<sup>24</sup> which is apparently an inherent physiological trait.<sup>68</sup> The number of twists varies, depending principally on the configuration of the pedicle. Subsequent pathological changes are the result of local circulatory interference.

With the restriction of venous return, intravascular pressure within the distal mass rises to the level of systole, unless the arterial pressure has been previously cut off by the compression of the torsion itself. The rapid rise in intracapillary pressure

leads progressively to edema, diapedesis, extravasation of blood and an effusion of a considerable amount of serosanguineous fluid into the peritoneal cavity (or the hernial sac). The affected omental tissue has been undergoing a polychromatic deviation from its usual pale yellow, having become reddish with engorgement, dusky blue with congestion, and turning purple with extravasation, and black with gangrene.

Histologically, early stages show marked vascular engorgement with perivascular infiltration. Later, the essential finding is one of acute hemorrhagic infarction. The ensuing variety of cellular degeneration depends upon the rapidity and completeness of circulatory strangulation. A replacement fibrosis is found where strangulation is slow or incomplete. Stasis, intravascular thrombosis, and infarct formation follow total arrest of the circulation with resultant necrosis. The dead tissue acts as a foreign body, inducing inflammatory changes (contiguous parietal thickening, and hyperemia of adjacent structures), which may progress to an aseptic peritonitis. Organisms from adjacent bowel may penetrate to the necrotic mass, and the infection result in an abdominal abscess. In the absence of any infection, the mass may undergo atrophy, and rarely, absorption of the entire gangrenous mass may take place. More rarely still, the pedicle is auto-amputated, and the omental tumor, now a mendicant, supplements its disturbed nutrition by parasitic attachment to available peritoneum or adjacent normal omentum.

*Clinical Comments and Diagnosis.* Like other uncommon ailments, the diagnosis of omental torsion requires wide clinical experience and an astute mind. Andrews<sup>4</sup> listed seventeen intra-abdominal affections which it may simulate. In approximately 85 per cent of the cases reported, the preoperative diagnosis was appendicitis, but it is interesting to note that, of these cases, a McBurney incision was employed in about 15 per cent, indicating an element of

doubt and a desire to be prepared for further exploration. Next in frequency of mistaken diagnosis was that of a diseased gallbladder, possibly because of the history of previous gastrointestinal upset. A preoperative diagnosis of a twisted ovarian cyst has also been made especially when a mass was noted on vaginal examination.<sup>36,101</sup>

The true diagnosis might be suspected in the hernial type because of the previous history or the presence of a hernial mass. Even this faint clue is absent in the primary abdominal type, and the diagnosis is often made by intuition alone. Lejars,<sup>56</sup> Morestin,<sup>67</sup> and Payr,<sup>76</sup> among others, have been credited<sup>69</sup> with confirmed preoperative diagnosis. Having published a concise review of the literature on "Primary Torsion of the Great Omentum," D'Errico<sup>24</sup> felt justified in making definite diagnosis in a case<sup>25</sup> with which he was confronted shortly after. Smythe,<sup>90</sup> Jeffries,<sup>80</sup> and Andrews,<sup>4</sup> among others, prepared tables for the differential diagnosis from appendicitis, but there are no characteristic symptoms nor specific diagnostic aids which justify distinction except for a palpable intra-abdominal tumor mass. It must also be kept in mind that appendicitis may be the precipitating factor for intra-abdominal (secondary) omental torsion, and that both conditions might exist simultaneously.<sup>76</sup> Torsion occurring during pregnancy has also been reported.<sup>14</sup>

Swain<sup>96</sup> attributes the difficulty in differential diagnosis to "the fact that the early symptoms of acute abdominal trouble are generally the same, whatever the cause may be." He points out that abdominal symptoms are produced, not so much by the lesion itself (cutting or crushing the omentum is painless)<sup>37</sup> but by its peritoneal reaction, hence the similarity of early symptoms. Morely,<sup>66</sup> having observed that "the great omentum contains no afferent splanchnic nerve fibers capable of causing visceral pain when it is strangulated," concluded from his researches upon abdominal pain that in "cases of intra-abdominal torsion of the great omentum

the pain caused is entirely local and is due to contact between the swollen and infiltrated omentum and the sensitive parietal peritoneum."

Clinical symptoms, such as pain, nausea and vomiting, and physical findings such as tenderness, acceleration of the pulse, fever, and leucocytosis are really non-specific pathologic manifestations of reflex sympathetic irritation responding to a physiologic pattern. The clinical syndrome is identical no matter what the cause and type of disorder may be, but its severity is proportionate to the intensity of (peritoneal) irritation produced.

Abdominal pain, sometimes mild, more usually severe, is the primary complaint. Its onset is usually sudden, although there is frequently a history of previous vague abdominal symptoms suggestive of sub-acute appendicitis or gallbladder disease. The pain is constant and does not radiate. The site of the pain is dependent upon the portion and proportion of the omentum undergoing rotation or torsion. Where the entire omentum is involved there is generalized abdominal pain, while, when only a portion undergoes twisting, the reaction is localized to the general area involved (almost invariably the right lower quadrant). The reason for this predilection has been ascribed by various authors<sup>8,69</sup> to anatomic variations and congenital anomalies in this area, which undoubtedly favor torsion by providing ideal mechanical "soil" for twisting. However, the relative unimportance of this factor is demonstrated by statistical evidence as presented by Bernstein,<sup>7</sup> that, although ovarian tumors occur with almost equal frequency on both sides, yet ovarian torsion is twice as frequent on the right lower quadrant to the fact that, in addition to being the site of more frequent pathologic processes, it is the seat of greater physiologic activity, since intestinal peristalsis and changes in intra-abdominal pressure tend toward its direction. The clinical appearance and the severity of the pain depends somewhat upon the amount of omentum involved,

but is mainly determined by the suddenness and extent of vascular obstruction. Although torsion is appreciated as a clinical entity in the acute phase only, there is ample evidence that axial rotation has either previously taken place or has been going on for some time. Symptoms are the result of vascular obstruction, and until this occurs, there are no complaints except vague abdominal discomfort, and no pathological changes are present. Moynihan is quoted<sup>6</sup> as stating that "rotation in the omentum (or other organs as the ovary with a cyst) does not occur suddenly; the acute change is not the twisting of the pedicle, but the thrombosis of the vessels which have long been twisted."

Nausea and vomiting are present in about half the cases. Absence of this symptom has been advanced by many authors as the differential criteria from appendicitis, but it has been noted in 50 per cent of the reported cases. Fever rarely exceeds a rise of one degree, and the occasional chill complained of may be accounted for on the basis of vascular thrombosis. The pulse may be slightly quickened. The leucocyte count is usually increased, varying from 12,000 to 25,000. High polymorphonuclear counts may be explained as due to the peritoneal irritation of the tumor and its hemorrhagic exudate. Tenderness over the affected portion (usually the right lower quadrant) is present on deep palpation. Local superficial hyperesthesia may be present when the mass becomes adherent to the anterior abdominal wall. Local spasm and rigidity may also be found, dependent upon the stage and site of underlying disease.

One surgical sign which can be regarded as being specific for the diagnosis of omental torsion is the discovery, at an early stage in the disease, of a mobile, diffuse tumor mass, usually in the right lower quadrant. In order to utilize this diagnostic aid, the clinician must not only look for it, but he must possess a keen palpatory perception, since it is usually obscured by local rigidity, distention, and obesity. A similar

mass, fixed and extremely tender, developing after several days, is indicative of an appendicular abscess. If the abdomen is examined in omental torsion, the mass is further obscured by an appreciable amount of intraperitoneal fluid, which may be detected by appropriate clinical technics. It has also been claimed by some authors that percussion over the right lower quadrant in acute appendicitis produces resonance distinguishable from the dullness elicited in omental torsion.

The incidence of omental torsion is greatest in the middle-aged, although individual cases from all decades have been reported. Its predominance in the male is marked, and even in the primary type the incidence is 22 males to 9 females. If the cases secondary to inguinal hernia are included, the ratio is further increased. The three cases reported in our series are all males. With very few exceptions, obesity is characteristic of the patient with torsion. Morris<sup>69</sup> describes this adipose figure as the "torsion habitus." Our own cases conform to this body type.

*Treatment.* If the preoperative diagnosis of omental torsion is ventured, laparotomy must be performed for confirmation and correction. In our opinion, a right paramedian sub-umbilical incision provides the best approach for investigation and operative accessibility. Upon opening the peritoneum, a considerable amount of serosanguineous transudate will be found, depending upon the size of the mass, the stage of circulatory obstruction, and the time elapsed before operation. Andrews<sup>4</sup> considers that "the presence of bloody fluid (upon opening an abdomen) makes the search for an omental torsion mandatory."

The appearance of the affected area of the omentum (as described under surgical pathology) depends upon the degree of circulatory obstruction and the length of time elapsed before operation. Its texture has been compared to "a sponge which has been left inadvertently in the abdomen," and also to "wet paste-board." The actual size of the twisted mass is enlarged

by hemorrhage and edema. Structures adjacent to the twisted mass will naturally undergo mild inflammatory changes and a perfunctory surgeon may be led astray by the false scent of a hyperemic appendix or gallbladder and regard it as the primary culprit. In those cases in which the appendix or gallbladder is accused and an omental torsion is not even suspected, the innocent organ may be removed and the omentum overlooked entirely. The postoperative persistence of a tumor will be erroneously regarded as an inflammatory mass unless the rotated portion of the omentum is discovered, followed centralward, and the diseased portion removed surgically.

It is unwise (and in violation of elementary surgical precepts) merely to unroll the twisted portion and restore it to the peritoneal cavity. Even if the entire omentum is involved, it should be removed without hesitation *in toto*, by ligating sections individually along the proximal border. Draper and Johnson,<sup>28</sup> having performed over 200 total omentectomies without an attributable mortality, believe that "this recessive structure (the omentum) should receive the same surgical consideration accorded to any tissue which has become useless and menacing through any combination of disuse and disease." During its removal, the diseased portion should be handled gently to prevent dislodging any thrombi into the circulation. The remainder of the abdomen should be searched for concomitant disease, which may also shed some light on the etiology of torsion. The hernial orifices should especially be examined. Drainage is unnecessary. Unless there are complicating factors so indicating, there is no reason to insert any of the sulfonamides.

Operation should be performed promptly. Procrastination is unwise. Delay results only in more toxic absorption from the necrotic, diseased mass, an increase in peritoneal irritation with the development of peritonism, and the formation of local adhesions. It invites the inception of complications. Mechanical intestinal obstruction

tion has been traced to omental torsion on autopsy and laparotomy.

Either septic or aseptic peritonitis may develop, depending on the fate of the necrotic portion. In one case<sup>104</sup> it was found to have withered, so "it would be impossible to estimate how long the mass would have taken to disappear." Aseptic sloughing with the evolution of an intraperitoneal free foreign body is also possible. Auto-amputation of the twisted omentum has been discovered at laparotomy with the diseased mass adherent to some distant structures interfering with their functions.

Mortality and morbidity in the uncomplicated cases with early operation is practically nil.

#### CASE REPORTS

CASE 1. (Chart No. 86092). A. R., a thirty-two year old white, married, male, was admitted to the hospital on September 9, 1937, complaining of right lower quadrant pain radiating toward the midline, of two weeks' duration. The past history was essentially negative except for a previous admission to the same hospital two years ago. At that time the patient had an incarcerated left inguinal hernia of twenty-four hours' duration. The sac contained a piece of omentum which was incarcerated and the omentum was returned to the abdomen *in toto*.

The present illness began twelve days prior to admission, with sudden onset of cramps in the right lower quadrant while the patient was at work. There was no nausea or vomiting. Bowel movements were normal. The patient took a bottle of citrate of magnesia which aggravated the abdominal pain. The following day the patient felt better and continued thus until three days before admission to the hospital. At this time he was again seized with severe right lower quadrant pain associated with nausea and vomiting, which was followed by chills and fever on the following day. The pain radiated to the midline and there was an associated dysuria.

On admission the patient was acutely ill. He was obese, lips parched, tongue dry and coated. Heart and lungs were normal. Abdominal examination revealed a left healed inguinal hernia incisional scar which was not

tender, with no evidence of a recurrent hernia. The entire lower abdomen was spastic, more so on the right side with marked tenderness over the right McBurney's area. No masses could be palpated because of obesity, but there was dullness on percussion over the right lower quadrant. There was no evidence of hernia in the right inguinal region. Rectal examination revealed a bogginess in the right side high up. The following data were obtained on admission: Temperature, 101.8°F., pulse, 100; respiration, 24; blood pressure, 134/74; red blood cells, 5,000,000; hemoglobin, 90 per cent; white blood cells, 15,900; polymorphonuclears, 92 per cent; monocytes, 8 per cent, and the urine was normal.

A diagnosis of acute appendicitis was made and after correcting the patient's fluid and electrolyte balance the patient was prepared for surgery.

Under spinal anesthesia the abdomen was entered through a right lower transrectus incision. Exploration of the abdomen revealed a moderate amount of serosanguineous fluid and a large purplish mass rolled into a ball occupying the right iliac fossa. Following this mass cephaloid it was found to be twisted in the middle of its long axis and was suspended by two cord-like structures about  $\frac{1}{8}$  inch in diameter from the greater curvature of the stomach. Through these cord-like structures ran good sized blood vessels. The entire mass was easily separated from its location by finger dissection and exteriorized and the suspending connecting cords were clamped, cut and ligated with No. 2 catgut sutures. The tumor mass was the entire great omentum. The appendix was retrocecal, retroperitoneal and removed as a routine measure.

The patient had a moderate postoperative reaction which lasted two days and the remaining stay in the hospital was entirely uneventful. The patient was discharged from the hospital on the twelfth postoperative day in excellent condition.

The specimen consists of the great omentum, double layered which is more than 15 by 14 inches in size. At one end it is rolled and indurated, dark, deeply hemorrhagic and section here reveals extravasated blood into the loose tissues and vessels plugged with blood clot. The major portion, however, is still fine and delicate, though here, too, vessels hold blood clot.

The vessels are all markedly distended with red blood cells, and a few also hold fibrin. The tissue is the seat of extensive extravasation of blood. *Diagnosis:* Hemorrhagic infarction of the omentum. The section of the appendix did not show any inflammatory infiltration.

CASE II. (Chart No. 92985). D. Z., an eighteen year old single male, was admitted on October 2, 1938, complaining of dull periumbilical pain, nausea and vomiting of four days' duration. On the day of admission the pain localized in the right lower quadrant with increasing severity. Family and past history were essentially negative. On examination the patient did not appear acutely ill. The abdomen was soft and not distended with no masses palpable. There was tenderness and spasm over the lower right rectus, more marked over the right McBurney point. The blood count showed a leucocytosis, viz., white blood count, 13,076; polymorphonuclears 76 per cent; monocytes 24 per cent, and the urine was normal.

Operation was performed on the following day for an acute appendicitis. Under spinal anesthesia, the abdomen was opened through a lower right paramedian incision and the following operative findings were recorded: The lower pole of the great omentum had three twists, clock-wise, involving the omentum for about 4 inches. It was edematous and hemorrhagic. The appendix was distended and in the middle of the appendix was lodged a foreign body about  $\frac{3}{4}$  inch long and  $\frac{3}{8}$  inch wide, resembling half of a prune pit. The involved omentum was resected and the appendix removed. The postoperative course was uneventful and the patient discharged from the hospital on the eleventh day postoperatively, with wound healing by primary union.

The specimen consists of a piece of omentum 10 by 8 cm. and  $1\frac{1}{2}$  cm. thick, dark red, thickened with vessels distended with blood. The appendix is 6 cm. long, 0.5 cm. in external diameter. The serosa is glistening, the wall 1 to 2 mm. thick. The lumen holds hemorrhagic material, and two pieces of foreign material, one a soft piece of what looks like orange seed, another larger piece, about 1 cm. long, a few mm. wide, part of a hard fruit seed. The mucosa is for the most part intact.

*Microscopic findings:* Omentum section shows vessels distended with blood and early thrombus formation. There is extensive extravasation of blood, and a polymorphonuclear reaction.

The appendix sections show no inflammatory infiltration. *Diagnosis:* Hemorrhagic infarction of omentum; appendix with foreign bodies in lumen.

CASE III. (Chart No. 109650). S. S., a forty-eight year old white male, was admitted to the hospital on December 11, 1940, complaining of severe right upper quadrant pain of three days' duration. The family history was not contributory and except for malaria twenty-five years previously, the past medical history was entirely negative. Previous gastrointestinal disturbances (flatulence, postprandial distress, etc.) were denied.

The present illness began three days before admission, when the patient arose with some slight pain in the right upper quadrant. He ate well and had a good bowel movement, but the pain increased in severity as the day went on. The patient had some nausea and as the pain increased in severity the patient found it "hard to breathe."

Examination revealed a well nourished white male, lying in bed with acute distress in the right upper quadrant. Abdominal examination elicited tenderness, spasm and a sensation of a palpable mass in the right upper quadrant. A diagnosis of acute cholecystitis was made and the patient prepared for surgery.

His temperature was  $100.4^{\circ}\text{F}$ .; pulse, 88; respirations, 20; blood pressure 124/75; urine normal; red blood cells, 4,220,000; white blood cells, 13,350; hemoglobin, 94 per cent; polymorphonuclears, 88 per cent; monocytes, 12 per cent; blood chemistry essentially normal.

Under spinal anesthesia, a right rectus incision was made, and on opening the celomic cavity a large piece of twisted omentum, about 5 inches long presented itself which was of granular consistency with engorged blood vessels. There was a moderate amount of serosanguineous fluid in the abdominal cavity. Further exploration revealed the liver to be enlarged, the gallbladder compressible, normal in size and appearance, and the stomach, intestinal tract including appendix all appeared normal to palpation and vision.

The omentum was clamped above the twisted portion and excised distal to clamp. A suture ligature was applied and the clamp removed. The abdomen was closed in layers. The patient's recovery was uneventful.

Pathologic report: Hemorrhagic infarction of omentum.

## SUMMARY

1. Three cases of intra-abdominal omental torsion are reported.
2. This is a clinical entity which is neglected unjustifiably in the differential diagnosis of an acute condition of the abdomen with obscure etiology. Not only is a preoperative diagnosis rare, but it is hardly ever considered in clinical surgery.
3. A brief review of the omentum is given, outlining its embryology, phylogeny, histology, anatomy, and physiology.
4. Several theories explaining the etiology and mechanics of omental torsion are presented.
5. The pathology of omental torsion is briefly reviewed, and the differential diagnosis, treatment, and prognosis discussed.

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# INTERCOSTAL NERVE BLOCK IN BALANCED ANESTHESIA\*

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THE science of anesthesiology has made tremendous strides in the last few decades after a long period of relative inertia. After the first use of ether by Long in 1842, for the next fifty years the only agents used were for inhalation, nitrous oxide, ether, and chloroform being the most widely known. At the turn of the century, Bier opened a new field when he demonstrated the possibility of the subarachnoid injection of cocaine for the production of anesthesia of a group of spinal nerves. In the present era, Labat has been the great exponent of regional anesthesia produced by local infiltration of the nerves supplying any specific area. The intravenous injection of ultra short acting barbiturates and refrigeration by ice are perhaps the newest methods of producing anesthesia. From the original armamentarium of one agent, the anesthetist now has a great many agents and methods at his disposal, and it is his duty to select the best anesthetic for each individual patient.

Lundy,<sup>1</sup> in 1926, first coined the term "balanced anesthesia" to indicate the use of a combination of anesthetic agents and methods so balanced that the burden of pain relief and the production of conditions compatible with surgery are not borne by any one method but rather by the combined effects of several. This principle has long been in use. The addition of ether vapor to a mixture of nitrous oxide-oxygen was one of the earliest examples of the use of a combination of anesthetic agents. The use of sedatives, as opiates, in the preoperative period tends to allay fear and apprehension and decreases the amount of anesthetic agent needed. Rectal anesthesia with avertin fluid (tribomethanol in amyl-

ene hydrate) partially anesthetizes the patient and greatly decreases the amount of inhalation agent needed. Under spinal anesthesia, a light cyclopropane or nitrous oxide-oxygen analgesia relieves nausea and pain from traction on visceral attachments. Sodium pentothal can also be used for this purpose.

In the average good risk patient almost any anesthetic procedure, if in the hands of an experienced and trained anesthetist, will produce satisfactory results. In the group of poor risk patients, however, on whom desperate and emergency surgery is being done, the subject might not stand large doses of any one agent, and it is here that the use of balanced anesthesia is of great value.

## TECHNIC

The first step in the production of balanced anesthesia is the proper preoperative preparation of the patient. These people are usually acutely ill and very often belong to the older age group. The preoperative use of intravenous fluids, oxygen, and other supportive measures are beyond the scope of this paper. We will concern ourselves only with the sedation necessary for the proper functioning of the anesthesia.

A very careful estimation of the patient's strength and condition must be made and enough medication given to produce a sleepy, drowsy patient without overdosage. Nembutal gr.  $1\frac{1}{2}$  by mouth and morphine sulphate gr.  $\frac{1}{8}$  to  $\frac{1}{6}$  with scopolamine hydrobromide gr.  $\frac{1}{200}$  to  $\frac{1}{150}$  by hypodermic, all given one hour preoperatively, have proved very satisfactory in producing sufficient sedation without undue depression. The nembutal also helps ward off any

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toxic effects of the procaine. An awake, apprehensive patient is a poor subject on whom to start a procedure such as this.

was started first. This is not done, however, when using sodium pentothal as the supplementary agent.

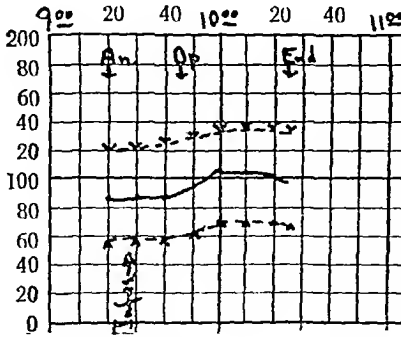


FIG. 1. Anesthesia record in Case I.

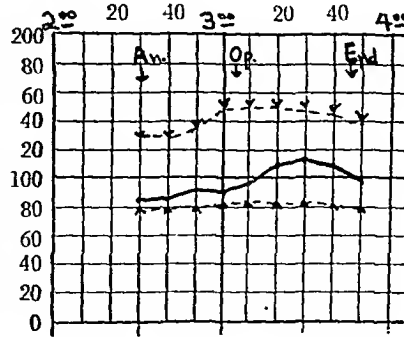


FIG. 2. Anesthesia record in Case II.

Upon arrival in the operating room, the intercostal block is done according to the technic described by Bartlett.<sup>2</sup> The skin is surgically prepared with any suitable antiseptic solution and draped with sterile towels. Preliminary skin wheals are raised with 1 per cent procaine over ribs seven through eleven in the midaxillary line. It is here that the intercostal nerves run in a closed compartment between the internal and external intercostal muscles and are easily accessible. From 3 to 5 cc. of 2 per cent procaine solution are deposited in each interspace just under the internal surface of the rib after careful aspiration has been done to ascertain whether or not the needle has punctured the pleura or is in one of the intercostal vessels. The procedure is carried out on both sides, and when one has achieved a fair degree of dexterity it should not take more than a few minutes. The surgeon must now wait from five to ten minutes until the anesthesia has set in as evidenced by loss of sensation to skin stimuli and relaxation of the musculature of the abdominal wall. When satisfactory, the operation can be started, and the patient put to sleep while the skin and fascia are being incised and before the peritoneum is opened. At first the block was done under local infiltration anesthesia, but the procedure was quite disturbing to the patient, and in subsequent cases, when feasible, the general anesthesia

The regional block can be supplemented by either inhalation or intravenous anesthesia, just enough of the agent being given to put the patient to the lower first or upper second plane of third stage surgical anes-

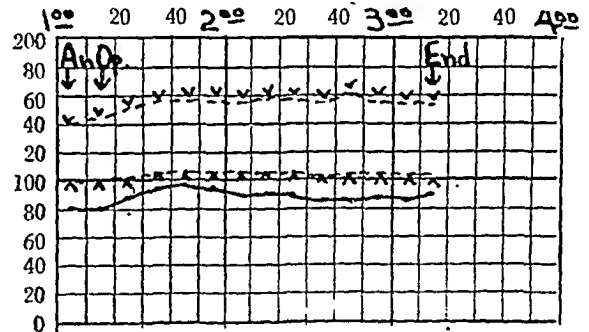


FIG. 3. Anesthesia record in Case III.

thesia (after Guedel<sup>3</sup>) in order to eliminate pain from traction on the abdominal viscera. Relaxation has already been obtained through the nerve block. In three of the cases used for illustrative purposes Novest-Oil was used instead of procaine. Novest-Oil is an oily solution of monacaine which is now being investigated as an agent for producing prolonged anesthesia of the upper abdominal wall by means of intercostal block. With this oily solution the onset of anesthesia is delayed about twenty minutes, which time is usually taken to prepare and drape the patient and incise to the peritoneum.

This use of balanced anesthesia has found favor with the surgeons since it pro-

vided excellent working conditions in every instance with minimal depression of the patient. The wide variety of available

branch block was transferred from the medical service for exploratory laparotomy.

Premedication of nembutal gr.  $1\frac{1}{2}$ , morphine

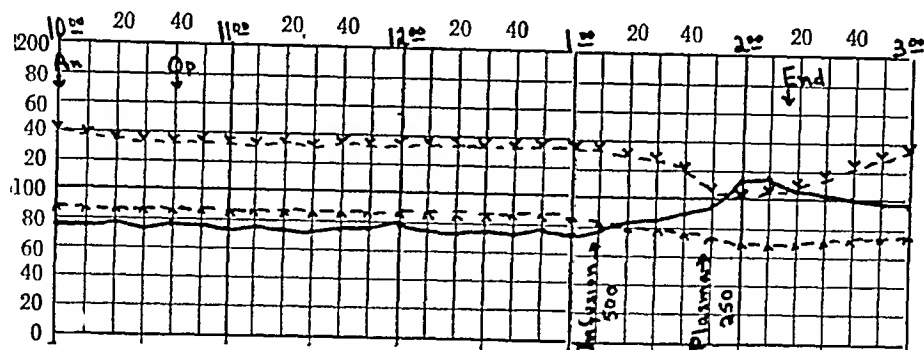


FIG. 4. Anesthesia record in Case IV.

agents gives the method great flexibility. The examples in the case reports show the different combinations that can be used.

#### CASE REPORTS

**CASE I.** B. B., a sixty-five year old, swarthy, markedly jaundiced, white male in very poor condition with a high spiking temperature and deranged fluid balance was admitted with a diagnosis of upper abdominal abscess of unknown etiology, and an exploratory laparotomy was decided upon.

Premedication of nembutal gr.  $1\frac{1}{2}$ , morphine sulfate gr.  $\frac{1}{6}$  and scopolamine hydrobromide gr.  $\frac{1}{200}$  was given at 8:30 A.M. Intercostal block with procaine, 2 cc. of 2 per cent at T7 through T11 bilaterally, was done from 9:15 to 9:25 A.M., and after an infusion of 5 per cent glucose in saline was started at 9:30 A.M. and nitrous oxide-oxygen 50 per cent at 9:35 A.M., the patient was prepared and draped, and the operative procedure started at 9:45. The operation consisted of opening the abdomen through an upper right rectus incision, evacuating as much pus as possible, insertion of several drains, and closure, completed at 10:25 A.M.

The anesthesia was satisfactory from the surgeon's point of view, and the patient was in as good condition at the end as when he started. The patient was kept lightly asleep, and if necessary for any extensive operative procedure, the anesthesia could readily have been deepened. There was no depression from the anesthetic and no shock.

**CASE II.** C. J., a fifty-four year old, deeply jaundiced white female with hypertensive heart disease, coronary sclerosis, and right bundle

sulfate gr.  $\frac{1}{6}$ , and scopolamine hydrobromide gr.  $\frac{1}{150}$  was given at 1:45. General anesthesia with nitrous oxide-oxygen and ether vapor started at 2:30, and bilateral intercostal block with  $1\frac{1}{2}$  cc. Novest-Oil at each interspace from T6 through T11 was done from 2:35 to 2:45. The incision was made at 3:05, an inoperable carcinoma of the gallbladder with metastasis to the liver was found, and after biopsies were taken the wound was closed and the patient returned to her room in excellent condition.

Due to the relaxation obtained from the regional block, the patient was not put any deeper than the upper second plane of surgical anesthesia and was reacting on her return to the room. The advantages of a minimal dose of anesthetic agent are great in severe liver disease.

**CASE III.** J. R., a sixty-six year old, obese, white female with hypertensive heart disease, arteriosclerosis, bronchiectasis, and a draining fistula from a cholecystostomy for empyema of the gallbladder one year previously was admitted for cholecystectomy and common duct exploration.

Premedication of morphine sulfate gr.  $\frac{1}{6}$  and atropine sulfate gr.  $\frac{1}{150}$  was given at 11:00 A.M. Under local infiltration anesthesia with 1 per cent procaine bilateral intercostal block from T6 through T11 with 2 per cent procaine was done from 12:50 to 1:05 P.M. The incision was made at 1:15 P.M. and immediately after general anesthesia with a cyclopropane-oxygen mixture was begun. The patient was kept lightly asleep in the lower first plane of surgical anesthesia until the skin was closed at 3:15 P.M. She reacted very quickly,

speaking rationally by the time she was placed in bed. The operation consisted of cholecystectomy and removal of a large impacted stone in the common duct.

with spinal anesthesia, without its dangers. Novest-Oil was used since a sufficiently long block could not be obtained with procaine.

CASE V. E. G., a sixty-four old obese, white

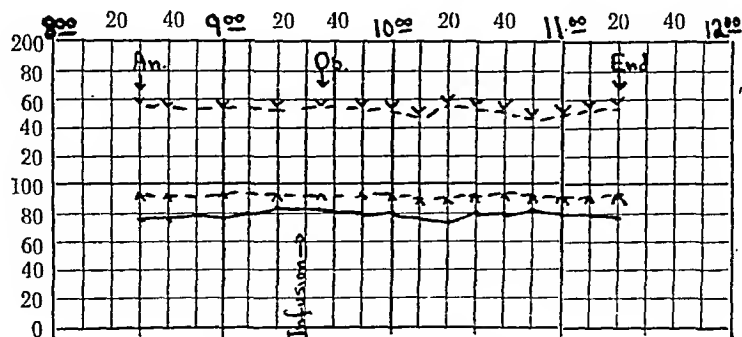


FIG. 5. Anesthesia record in Case v.

The anesthesia was perfect in that there was complete upper abdominal relaxation, respirations were thoracic in nature with quiet abdominal contents, and the condition of the patient did not change during the operative procedure.

CASE IV. C. H., a sixty-three year old, white, obese female in good condition with blood pressure 140/90 was admitted for cholecystectomy and common duct plastic.

Premedication of morphine sulfate gr.  $\frac{1}{6}$  and scopolamine hydrobromide gr.  $\frac{1}{150}$  was given at 9:15 A.M. General anesthesia with nitrous oxide and oxygen was started at 10 A.M. and bilateral block of intercostal nerves T6 through T11 done from 10:05 to 10:15 A.M. with  $1\frac{1}{2}$  cc. of Novest-Oil at each space. At 10:20 A.M. ether was added to the anesthetic mixture, the patient induced to the second plane of surgical anesthesia and intubated at 10:30 A.M. The operation was started at 10:40 A.M. and completed at 2:15 P.M. After three hours of anesthesia the pulse rate began to rise and the blood pressure fell. This was effectively combated with an infusion of 500 cc. of saline followed by 250 cc. of plasma. The patient reacted on the way from the operating room to her bed.

The advantage of this combination of agents was commented upon by the surgeon. The block afforded complete relaxation, and the intubation resulted in quiet breathing which was thoracic in nature since the anesthesia was maintained in the upper second plane and diaphragmatic excursions were not accentuated. The end result of the combination was an abdomen similar to that found

female with hypertensive heart disease, enlarged heart, blood pressure of 168/90 and generalized arteriosclerosis was admitted with obstruction from carcinoma of the stomach. She was considered a poor operative risk, and a balanced anesthetic procedure was decided upon.

Premedication with morphine sulfate gr.  $\frac{1}{6}$  and scopolamine hydrobromide gr.  $\frac{1}{150}$  at 7:30 A.M. rendered the patient sleepy when she came to the operating room, and under local infiltration with procaine 1 per cent, intercostal block from T6 to T11 bilaterally with  $1\frac{1}{2}$  cc. of Novest-Oil at each space was done from 8:30 to 8:55 A.M. An infusion was started at 9:30 A.M., and when skin anesthesia of the upper abdomen was present at 9:35 A.M., the incision was made. At 9:40 A.M. the patient was put to sleep with a  $2\frac{1}{2}$  cc. solution of sodium pentothal injected into the intravenous tubing, and immediately thereafter the mask of the anesthetic machine was applied to the face and a 50:50 mixture of nitrous oxide and oxygen was administered. The carcinoma was not resectable, and a gastroenterostomy done. The operation was concluded at 11:20 A.M. with the patient in excellent condition.

The use of the nitrous oxide-oxygen mixture with sodium pentothal served several purposes. First, the amount of pentothal needed was markedly decreased, only 50 cc. of  $2\frac{1}{2}$  per cent solution (1.25 Gm.) being used in a two-hour procedure. Secondly, the use of the anesthesia machine provided an effective way of measuring the depth of respiration and level of anesthesia by watching the excursions of the rebreathing bag. Third, the 50 per cent oxygen

content of the mixture was considerably more than can be obtained from atmospheric air.

#### COMMENTS

To produce the muscular relaxation demanded by the surgeon when working in the upper abdomen, it is necessary to give a large amount of any anesthetic agent. In the case of sodium pentothal intravenously, this relaxation is unobtainable without approaching much too closely a toxic dose. There results a profound depression with deleterious effects upon the patient and his subsequent postoperative course. It has proved unsatisfactory when used alone.

The use of inhalation agents as ether or cyclopropane to produce adequate relaxation necessitates at least lower second or upper third plane third stage anesthesia (after Geudel). This level, in a patient in poor condition, is undesirable since the patient is frequently unable to maintain his cardiorespiratory system either during the operation or in the immediate postoperative period and sinks rapidly. Even if able to cope with the depression caused by the anesthetic and operative procedure, the postoperative course often is stormy.

In an excellent paper published recently by Evans<sup>4</sup> while this study was being made, he pointed out the advantages of intercostal block with procaine combined with intravenous sodium pentothal in traumatic injuries of the abdomen when shock in varying degree was present. His studies were undertaken in an effort to find a suitable anesthetic for use by the military forces in the field where facilities were limited. The results of this valuable investigation showed that in this type of gravely ill patient, excellent anesthesia with minimal depression was obtained with the use of this combination. This controlled group of cases was done under conditions approximating as closely as possible those to be found in actual combat.

In our civilian hospitals working with all modern conveniences, this concept of balanced anesthesia can be carried further than was done by Evans, using both his

combination and the others already illustrated. It has been used here in combination with sodium pentothal, nitrous oxide, cyclopropane and ether. In one of the cases the inhalation agents were delivered by the endotracheal route, the patient being anesthetized just deeply enough to tolerate the presence of the tube in the trachea.

If for some reason the intercostal block does not produce the desired relaxation, nothing is lost, for then the anesthesia can be deepened to the required level using the inhalation agent. The great flexibility of the method giving the anesthetist complete control of the patient is especially desirable. The supplementary agents can be varied to meet the requirements of the individual case and can be changed during the operation should the necessity arise.

The method should not be restricted only to the gravely ill. Any patient who is operated upon should receive the benefits of the addition of intercostal block to the anesthesia if there is the slightest question of his ability to stand the anesthesia and operation, or if the abdominal relaxation desired by the surgeon will not be safely obtained with the anesthetic agent to be used.

#### CONCLUSION

A discussion of intercostal nerve block as a regional anesthetic to be used in conjunction with other agents in the production of a balanced anesthetic has been presented, and its merits in poor risk and other patients having upper abdominal operations considered. Typical case reports showing the application of balanced anesthesia have been given.

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# OPERATION FOR ANAL FISTULAS

## SOME REASONS FOR FAILURES

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**A**LTHOUGH the earliest records of medical history describe a relatively satisfactory operation for anal fistula, the fundamentals of which are still in use, there are probably few surgical procedures in which there is as high a percentage of failures.

A review of the records of 500 patients who came to the Mayo Clinic because of an anal fistula, or more specifically a draining sinus in the perianal, anal, or rectal region, disclosed that 43 per cent or nearly half of them previously had undergone from one to fourteen operations that had been unsuccessful.

The most frequent causes of the failure of operation to eradicate an anal fistula are as follows: (1) faulty conception of the origin and course of the disease, (2) confusion in regard to the anatomy, (3) confusion in regard to the terminology, (4) mistaken diagnosis, (5) fear of causing rectal incontinence, (6) inadequate post-operative care, (7) failure to appreciate the danger of performing anorectal operations in the presence of infectious diarrhea, (8) inadequate anesthesia and (9) lack of teaching facilities in medical schools.

### FAULTY CONCEPTION OF THE ORIGIN AND COURSE OF AN ANAL FISTULA

Almost all anal fistulas arise in a crypt at the dentate margin. Buie has described the following stages in the development of an anal fistula: (1) infection of a crypt of Morgagni; (2) extension of the infection along the course of least resistance, usually into the loose areolar tissue of the ischio-anal fossa; (3) tissue necrosis and abscess formation; (4) spontaneous rupture of the abscess. In a great majority of complete anal fistulas, this sequence of events is

true. However, an anal fistula may have as its primary source an ulcer or a fissure in the anal canal, but usually, in this event, it is a subcutaneous fistula. The primary or anal source of the fistula may be sufficiently large to permit the products of inflammation to drain back through it, thus obviating the necessity of a secondary opening and therefore resulting in an incomplete internal or external fistula, depending upon the course the abscess has taken. A fistula very occasionally may originate in the rectum itself, that is, proximal to the pectinate line, and progress from there to its secondary opening, in which event, however, it is no longer an anal but a rectal fistula.

### CONFUSION IN REGARD TO THE ANATOMY

It is a rare exception to read an article on anal fistula which does not go into great detail about the anatomy of the anal sphincters, particularly as to whether the external anal sphincter is composed of one, two, or three bundles. For didactic purposes, this may be perfectly well and good, but usually the same article will elaborate on whether or not, in the surgical treatment of the fistula, it is safe to cut one or all of the bundles. This is entirely beside the point, and the rules laid down by John Arderne more than 500 years ago still hold true, that is, to open the fistulous tracts from their source to their termination, regardless of how much muscle intervenes.

Perhaps another cause for confusion in regard to the anatomy is the variation of boundaries given by different authors for the limits of the anal canal. Some give the lower limit of the prostate gland but the majority use the pectinate line. The latter would seem much more logical from an

embryologic standpoint (that is, the junction of hindgut and proctodeum), as well as from the standpoint of the origin and spread of disease.

#### CONFUSION IN REGARD TO TERMINOLOGY

Based on the sequence of events in the development of a fistula, Buie has suggested a substitution of the term "primary opening" for internal opening and of the term "secondary opening" for external opening. This terminology would seem much more logical, since it is based on the course of development of the fistula and also because the term "external opening" would signify that the opening is on the outside or external part of the body, whereas, as a matter of fact, the external, or, more properly, the secondary opening, may be inside the rectum proximal to the dentate margin. Based on this terminology then, an internal fistula is one in which the primary source is in a crypt at the dentate margin and the secondary opening is proximal to the dentate margin. An external fistula is one with a similar primary source; however, the pus follows a course to the outside of the body and the secondary opening is distal to the dentate margin, usually in either ischio-anal fossa. An incomplete internal fistula or an incomplete external fistula is one in which no secondary opening has been established, principally because the drainage of pus back through the primary source is adequate to relieve the pressure. Strictly speaking, incomplete internal fistulas and incomplete external fistulas are actually not fistulas but chronic abscesses, since the word "fistula" is derived from the Greek word meaning "pipe," and connotes a primary and secondary opening. Buie has suggested that the terms "incomplete internal fistula," "incomplete external fistula" and "blind fistula" should be discarded. The respective lesions should be designated as sinuses or abscess cavities.

#### MISTAKEN DIAGNOSIS

By far the most common cause for a draining sinus at or near the anus is an anal

fistula. It is by no means true that all draining sinuses in this area are fistulas, and if one will keep in mind the other possibilities, much time and grief may be spared in looking in the anus or rectum for the primary source of a perianal sinus which does not exist. Smith<sup>3</sup> has classified the conditions which may cause draining sinuses in this area into four groups:

*Group 1.* This group includes those sinuses which are the result of spontaneous pyogenic inflammatory processes, such as (1) fistula in ano, (2) incomplete fistula or an abscess cavity, (3) sinus or fistula associated with fissure, (4) rectovaginal fistula which may and frequently is an anal fistula, (5) infection of the lymph vessels and (6) peri-urethral abscess. The term "rectovaginal fistula" is used loosely; the lesion usually is an anovaginal fistula.

*Group 2.* This group includes those sinuses which arise from normal or abnormal glands, from abnormally situated glandular tissue or from cystic lesions such as pilonidal cysts, chromaffin bodies, multilocular cysts, Bartholin cyst abscesses, pyoderma or hidradenitis suppurativa and dermoid cysts.

*Group 3.* This group includes those sinuses which are the result of specific or peculiar etiologic agents or gross injury such as tuberculosis, actinomycosis, osteomyelitis, penetrating injuries, lymphogranuloma inguinale and malignant lesions such as carcinoma, epithelioma and lymphogranuloma.

*Group 4.* This group includes pseudo-sinuses caused by superficial embryologic abnormalities or pathologic alteration of normal structures such as congenital anal dimples situated anteriorly or posteriorly, postanal dimple, comedones and great enlargement of hair follicles.

It is not the purpose of this study to go into the differential diagnosis, but Smith's outline of some of the processes which cause chronic anal or perianal sinuses serves to illustrate why any sinus in the perianal region should not be considered to be an ordinary anal fistula. However, one condi-

tion in group 2, namely, pyoderma or hidradenitis suppurativa, is being recognized more frequently. In the past this disease probably was diagnosed as so-called incomplete external or blind external fistula. It is now established that it is a disease of the apocrine sweat glands and the lesion usually does not communicate with the anus at all. If one remembers that the apocrine sweat glands are found in the skin of the perianal, inguinal, axillary and mammary regions and that more than one of these regions usually is involved, the differential diagnosis will be less difficult and much time saved in looking for the primary source of a fistula which does not exist.

#### FEAR OF CAUSING THE PATIENT TO BE INCONTINENT

Surgeons see many cases in which scars or wounds of previous surgical operations are present in the perianal region. Surgeons fear to cut through the muscle because of the danger of producing an incontinent anus. If the fistula is to be cured, the old rule still holds; namely, that all the tissue overlying the fistulous tract must be incised whether or not muscle intervenes. One of the chief causes of incontinence of the anal musculature is the custom of packing the incised fistula wide open, thereby causing a wide scar which prevents the remaining anal muscle from closing the anal orifice. Another reason for anal incontinence is permitting the inflammatory process to continue without treatment. In so doing, much more scar is formed and muscle tissue itself is destroyed by the pathologic process.

#### INADEQUATE POSTOPERATIVE CARE

Any anorectal wound should be regarded as a contaminated or infected wound and treated accordingly with hot moist packs, hot irrigations and daily inspection of the wound to prevent bridging of tissue. Thinking of the postoperative treatment at the time of operation by attempting to create flat, open wounds which do not block the drainage is important.

#### FAILURE TO APPRECIATE THE DANGER OF ANORECTAL OPERATIONS IN CASES OF INFECTIOUS DIARRHEA

It previously has been shown that an anal abscess or fistula occurs as a complication in a relatively high percentage of cases of chronic ulcerative colitis,<sup>4</sup> regional ileitis<sup>2</sup> and amebic dysentery. A surgical procedure on the anus is not desirable in such cases; for the most part, it should be limited to incision and drainage of abscesses. If any anorectal operation is done, it should be performed during a quiescent stage of the disease and even then it is liable to cause an exacerbation of the diarrheal disease. The wounds will heal very slowly.

#### INADEQUATE ANESTHESIA

Not an insignificant cause of failure of operations for anal fistula is poor anesthesia. In order to examine the anal canal adequately and determine the site of the primary source of the fistula, complete anesthesia of the anal musculature is usually necessary. For this purpose, caudal anesthesia and sacral block approach the ideal. If general anesthesia is used, it must be very deep. With local anesthesia, complete relaxation is difficult to obtain.

#### LACK OF TEACHING FACILITIES IN MEDICAL SCHOOLS

Certainly not the least important reason for the failure of operations for anal fistula is the lack of emphasis placed on the subject of proctology in the various medical schools of this country. If a proctologic department exists in a medical school, a very limited part of the curriculum is given to instruction in this specialty.

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# FIXITY OF FACIAL EXPRESSION FOLLOWING UNDERMINING OF THE SKIN OVER THE NOSE\*

## A MODIFIED METHOD BY WHICH IT IS AVOIDED

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**F**OLLOWING plastic operation on the nose, especially that for correction of hump, there occurs, after a varying interval of weeks, a mask-like lack of mobility of the tissues involved in the operation, which closely resembles in character that seen in patients with myxedema.

The presence of this condition is recognized both by the patient and others, and it thus becomes a factor of importance from several points of view, both for patient and operator. Depending upon the personality of the individual, even a temporary facial blemish of this sort may exert a particularly undesirable influence both socially and economically, and at best such an operative result requires emotional adjustment. This is usually more difficult because of the nature of the operation. Few patients wish to have the fact of a cosmetic operation publicized, when it does not arise from a deformity due to injury or disease, and the considerable length of time required for the re-establishment of normal tissue function is of special importance in this relation.

If the detail of the operation commonly employed for removing hump of the nose is examined, a cause for the occurrence of such a myxedematous appearance of the tissues will be made clear.

A button-end scalpel is passed through the left incision and carried directly over the nasal dorsum; then directed downward until it appears through the opposite nasal incision, where it is turned at right angles, following the course of the caudal part of the septum almost to the nasal spine.

To remove the hump, a nasal saw is introduced through the primary incision and is placed flush with the hump at the level at which the reduction of the profile is to be made. The forefinger and the thumb of the non-operating hand are placed on the side of the nose to protect the overlying skin.

The body and cartilaginous nasal elements and the perpendicular plate of the ethmoid are cut through with firm movement of the saw. When this technic has been carried out on both sides, a blunt-end knife is used to remove the separated fragment of bone. This is done by passing the knife to the upper end of the excised bone, then completely freeing the section of any remaining attachments by drawing the knife downward to the tip of the nose. This separates the fragment of bone completely, so that it can be extracted with suitable forceps.

Irregularities which may be present in the nasal bone following operation are smoothed off with a rasp, and an angulated knife is used to trim off the nasal cartilage.<sup>1-4</sup>

To complete the cosmetic effect following removal of the hump, the nasal arch is narrowed by further bony operation. Details of this later procedure are unnecessary to the understanding of the question under consideration.

From the foregoing, it is at once clearly evident that the skin, in the undermining process, must suffer considerable injury to its deeper parts and to the subcutaneous

\* From the services of Dr. George M. Coates, Graduate Hospital, University of Pennsylvania, and Dr. David N. Husik, Mount Sinai Hospital, Philadelphia, Pa.

tissues, particularly to its blood, lymph and nerve supply.

The skin itself has very definite lines of

vascular, its nutrition being derived from the plasma of the dermal vessels. The dermis is the foundation layer of the skin.

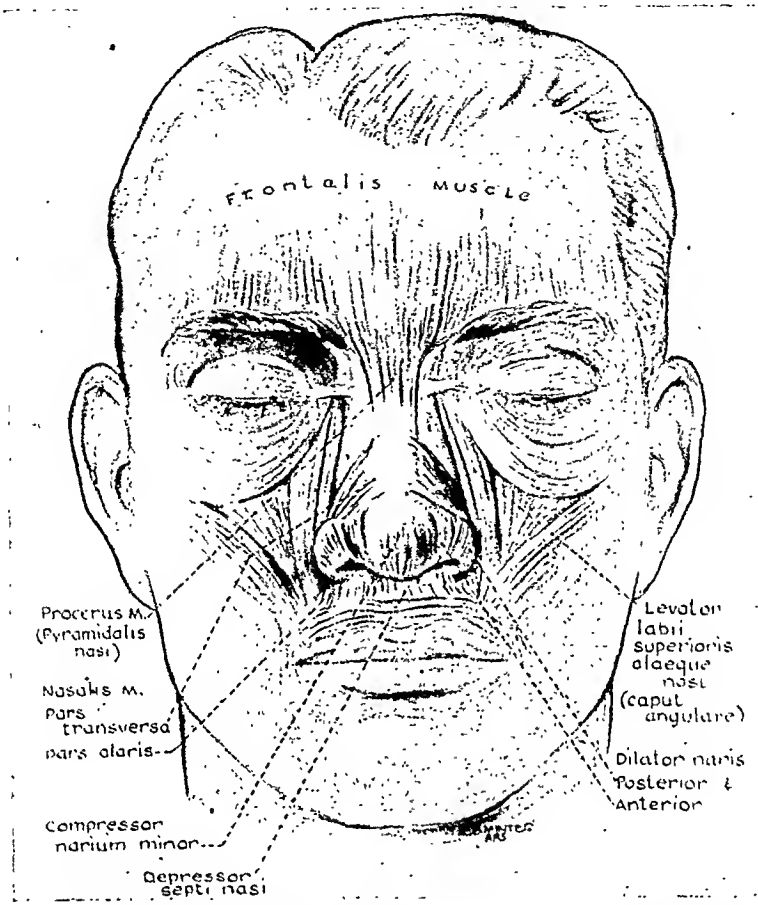


FIG. 1. Full face view showing facial muscles and intrinsic muscles of the nose.

tension everywhere throughout the body surface, which are known as Langer's lines.<sup>5</sup> In the area of the nose, these lines run from the mid-dorsum downward and medial ward on either side, to the corners of the mouth, in a sweeping curve. Their path represents very closely the area where the skin is undermined in the operation outlined, and where the later restricted mobility occurs. It has been demonstrated<sup>6</sup> that injury to the tissues associated with these lines may result in disturbance of the normal skin tension.

If the anatomy of the skin is closely examined, it is seen that there are two chief layers; (1) epidermis (cuticle); (2) dermis (corium). The epidermis is non-

The outer layer of the dermis is composed largely of white fibrous and yellow elastic tissue. It is somewhat vascular and also contains a number of nerve endings. The middle or reticular layer is closely connected with the subcutaneous tissue. This middle layer is made up of loosely-meshed, white and yellow elastic fibrils. It is of particular significance in the condition reported here, that these elastic fibrils run parallel with Langer's lines, which as already noted, are associated with normal skin tension.

The subcutaneous or inner layer of the true skin, or corium, is a loose network of connective tissue and contains the larger blood vessels, lymphatics and nerves of

the skin, as well as the deeper hair follicles, sweat and sebaceous glands.

The blood vessels in this deepest skin

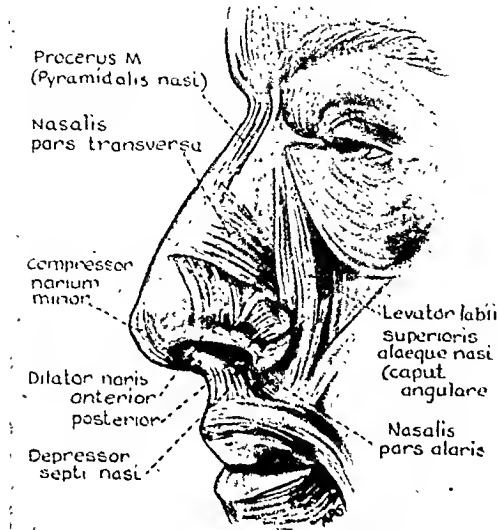


FIG. 2. Profile showing intrinsic muscles of the nose.

layer anastomose with each other freely to form a network, from which branches pass upward to form a second vascular network at the junction of the outer and middle layer of the corium. From this level, numerous vessels run to the superficial layer as terminal arteries. Here they turn at right angles and lie parallel to the skin surface.<sup>2</sup>

In their work on skin-grafting in burns, Brown and McDowell<sup>7</sup> report that epithelium is the only part of the skin that regenerates. The important pad of the derma does not regenerate to any extent, nor do any of the structures in it, such as elastic tissue, sebaceous or sweat glands. It is obvious that there is no destruction of the skin elements in an undermining operation, but through disturbance of vascular and nervous function a temporary change, involving all the dermal elements, similar in nature, though not similar in degree, might follow the operation of undermining of the skin. This would involve the elastic tissues, which, as has appeared, are represented on the skin surface by Langer's lines, the representatives there of the direction of skin tension.

The subcutaneous layer receives the greatest injury when the skin is undermined. This undermining process necessarily disturbs the blood vascular and lymphatic channels which pass from the underlying muscular layer to the focal area of skin involved in operation. The result of this disturbance is the creation of a circumscribed lessening of the sources of nutrition and a general lowering of metabolism of the skin concerned. In this way, an area of artificial, circumscribed myxedema is formed. Such a condition has been described entirely apart from operative procedure.<sup>8,9</sup>

Myxedema is most frequently seen in conditions in which there is reduced thyroid activity, but it may occur in other disturbances of normal metabolism. It is occasionally seen in pellagra, which is essentially a disease of disturbed nutrition.

The myxedematous process is a response of the skin to a lowered nutritional level. Chemically and histologically, an abnormal production of mucin by the epithelial cells is found and particularly by the connective tissue in the subcutaneous skin layer. The connective tissue is increased and infiltrated with mucin. There is an accompanying reduction of oxygen consumption and of nitrogen metabolism in the affected tissues.<sup>10,11,12</sup>

A study of the capillaries in myxedematous patients has been reported by Zondek and his associates.<sup>13</sup> On examination of the nailfold by suitable means, they found a reduction in the number of capillaries with a notable narrowing of the lumen in those present. In some instances, only a fine line, which was barely visible, represented the capillaries. No flow of blood could be distinguished, and no arterio-venous anastomoses could be seen.

Using the pressure plethysmograph, the rate of filtration through the capillary walls in myxedema has been measured by White and Jones.<sup>14</sup> They conclude that the slow filtration rate in myxedema is partly due to increased tissue resistance caused by the infiltration with viscid

myxedema fluid. This observation had already been made by Landis and Gibbon.<sup>15</sup> The extremely low rates in the cases of White and Jones became much higher when the metabolic rate had been restored to normal.

Altogether, these observations indicate that a disturbed nutrition (metabolism) from any cause may result in the production of mucin by the connective tissues of the skin, or by the epidermal cells. The infiltration of mucin (myxedema) characteristically causes a waxy consistency of the skin, with loss of elastic tone. It has already been noted that mucin in myxedema is present in the connective tissues of the deeper skin layers, and that these elastic tissues run parallel with Langer's lines, which represent planes of tension on the skin surface.

These findings in myxedema due to general systemic disturbance may well be applied in the condition under consideration. Clearly, it is hardly possible to make a direct study of the tissues in this condition, as biopsy is particularly contraindicated, and unnecessary, since the improved technic which is presented below affords a means of avoiding the undesirable result.

In considering a limitation of mobility in facial expression following nasoplastic operation, not only injury to skin takes place, but disturbance of underlying muscles must also be considered as a factor, although injury to muscles alone would not cause the waxy fixity of facial expression, which has been encountered following the customary operative technic.

The muscles of the nose are all derived phylogenetically from a single muscle, the primitive platysma. In some human races, this muscle is still sometimes present, extending over the face. In all vertebrates below the mammals, the superficial facial musculature is restricted to the region of the neck. In mammalia, this musculature has spread over the head and on to the face, where it has made extensive connections with the freely movable skin. Since

the matrix muscle of the neck was innervated by the facial nerve, all of the individual muscles evolved from it, including

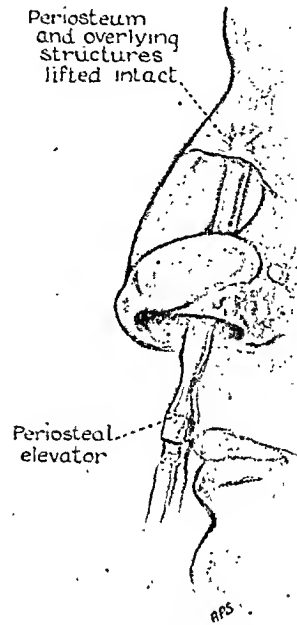


FIG. 3. Profile illustrating use of periosteal elevator, to avoid undermining the skin over the nose.

the nasal muscles, are innervated by facialis branches.<sup>16</sup>

The procerus muscle is continuous above with the medial portion of the frontalis, and actually belongs to the infraorbital group. This fact is based both on morphology and experiment. The fusion with the frontalis is a secondary connection. In "gibbons," the procerus muscle extends downward over the entire back of the nose.<sup>16</sup>

Ontogenetically, the development of the facial muscles in man is briefly a recapitulation of the main developmental stages of mammalian phylogeny.

The muscles of the nose vary between wide limits in the degree of their development, and one or more may be entirely absent. There is also a wide variation in their description by different authorities. However, if one bears in mind that all of these small muscles have arisen by special functional development from a single

parent muscle, the platysma, the many variations are clearly understandable.

The muscles of the nose<sup>3,17,18</sup> most constantly present are (Fig. 1):

1. Procerus (*pyramidalis nasi*) is a small pyramidal slip arising by tendinous fibers from the fascia covering the lower part of the nasal bone and upper part of the lateral nasal cartilage. It is inserted into the skin over the lower part of the forehead, at the root of the nose, between the eyebrows, where it interdigitates with fibers of the frontalis. It is in relation by its upper surface with the skin, and by its under-surface with the frontal and nasal bones. Its action exerts a slight drawing down of the inner angles of the eyebrows.

2. Nasalis (*compressor naris*) is in two parts: (1) The *pars transversa* is a triangular muscle extending from the bridge of the nose, where it is continuous by an aponeurosis with the muscle of the opposite side, and with the aponeurosis of the procerus. It is adherent to the skin and is only slightly attached to the underlying cartilage. Its fiber bundles converge toward the back of the wing, where they are attached to the skin along the line of the nasolabial sulcus. It is inserted beneath the nasal process of the quadratus labii superioris (*levator labii superioris alaeque nasi*) with which its fibers interdigitate. An attachment of origin is also sometimes described as occurring in the lower part of the canine fossa of the maxilla. (2) The *pars alaris* (*depressor alae nasi*) is a small quadrangular muscle, which is between the lower part of the nasal opening and the alveolar process of the maxilla. It is covered by mucous membrane of the oral cavity, by the orbicularis oris muscle, and by the quadrator (*levator*) labii superioris. It is fused laterally with the *pars transversa* (*compressor naris*). This muscle arises from the alveolar ridge of the lateral incisor and the canine teeth. Its fibers extend vertically to the skin of the dorsal margin of the nostril, from the dorsal portion of the cartilage of the wing to the

septum. Its action aids in down the nasal alae.

3. The *caput angularis* of the *quadratus labii superioris* (*levator labii superioris alaeque nasi*) is not an intrinsic, but an accessory muscle of the nose. It is a thin muscle which extends beside the nose from the inner margin of the orbit downward in two divisions, one of which joins the ala and the other is inserted into the upper lip. Its action is to raise both the ala and the lip, as well as to aid in dilating the nostril and in deepening the nasolabial fold.

4. The *dilator naris posterior* is a thin, triangular muscle which lies on the side of the nasal wing, partly beneath the *quadriceps labii superioris*. Its place of origin is in the skin of the nasolabial fold, and from the lesser nasal cartilage. It is attached to the inferior border of the nostril.

5. The *dilator naris anterior* is a very small, thin muscle which passes from the lower margin of the cartilage at the front of the wing of the nose to the skin near the margin of the nostril. It lies in front of the posterior dilator.

6. The *compressor narium minor* is a small muscle attached to the alar cartilage and inserted into the skin at the nasal tip.

7. The *depressor septi* arises from the incisive fossa of the maxilla and its fibers are inserted into the septum and the posterior part of the ala.

The names of the greater number of these muscles indicate their action.

Occasionally a small longitudinal muscular strip has been found, which runs from the frontal process to the body of the maxilla, near the lateral margin of the nostril. This unusual muscle is called the *anomalous*.

The vascular supply to the alae and to the septum are the alar and septal branches of the external maxillary vessels. The dorsum and the sides of the nose are supplied by the dorsal basal branch of the ophthalmic and the infraorbital branch of the internal maxillary.

Together with the development of the facial musculature, there is a differentiation also in the nerves which supply it. These consist of the complex terminal branches of the facial nerve.

The question of facial expression has received considerable scientific attention, particularly during the latter half of the last century, when detailed observations were made by such investigators as Darwin (1897), Lavater (1832), Duchenne (1863), Bell (1877), Henle (1858), and others. These studies ignored the factor of skin function in the consideration of facial expression due to emotional stimulus, and were confined to the muscles of the face, in greater part. Darwin<sup>19</sup> limited his record of nasal muscles in emotional expression chiefly to the pyramidalis (procerus) as an adjunct to the eye muscles concerned in weeping. Jabet<sup>20</sup> expressed the opinion that "The nose is an important index to character; mind forms the nose—not nose, the mind." If this were literally true, there would be scant need for plastic surgery.

The interest of Duchenne,<sup>21</sup> whose illustrations are familiar to medical literature, centered about his theory that it should be possible to investigate, by the study of the muscular action, the laws which rule the expression of the human face. Accordingly, he sought by means of the electric current to "make facial muscles speak the language of the passions and feelings." His work gives little attention to the nasal muscles. He characterized the combined levator alae nasi and the levator labialis superior as the "muscle du pleurer a chaudes larmes." The "transverse muscle" of the nose is assigned to the expression of shiftiness and lasciviousness, and the dilator naris is considered as the complementary muscle of such violent passions as anger and rage.

It is particularly noteworthy in relation to the subject of this paper, that when Duchenne showed his colleagues the photographs of his subjects illustrating the contraction of different facial muscle groups

in response to electrical stimulation, though they are the muscles of facial expression, it was not always possible to identify the pictures as typifying any given emotion.

This suggests the observation which can frequently be made in persons with facial palsy, that although voluntary movement may be impossible, emotional stimulation (to cause laughing or weeping) may bring out a considerable degree of muscular action, with the corresponding facial expression, which is not voluntary, but reactive. Many photographs which appear in the public prints, present facial expression due to voluntary muscle action, as in a purported smile, which is produced only by drawing back the corners of the mouth, but does not include the complex facial muscle action which follows true emotional stimulation. Duchenne concludes his description with the statement, that in repose the muscles still possess a force which "never sleeps" and that this force is tonicity.

The question of tonicity has been investigated and discussed at length. Following the introduction by Hunter, in 1924, of a theory of "plastic tone" (postural contraction), which considered that the cause of rigidity of striated muscle in spastic paralysis is due to the influence of the sympathetic nervous system, and various somewhat related ideas presented by others, numerous experiments have been done on ramisection. These experiments demonstrated that the innervation of the autonomic system is limited to the control of the vascular system, and that it does not otherwise affect muscle.<sup>22-27</sup>

Because of the importance of humoral influences, it is of interest to include the suggestion of Hinsey and Cutting (1933), that sensitized skeletal muscle may be caused to contract by elaborated sympathetic substances. The action of acetylcholine has been considered as an active factor in this relation.

Cobb and Wolff present the opinion that sympathetic nerves do not end in striated muscle, but that stimulation of



FIG. 4. Hump nose and irregular (unequal) nostrils; A, C and E, before correction; B, D and F, after correction.



FIG. 5. Hump nose with deflected tip; A, C and E, before correction; B, D and F, after correction.



these nerves controlling the blood vessels of a muscle may alter the tissue fluids and blood in such a manner that change in muscular contractility is brought about. This viewpoint is held also by Grinker. It may be only another way of expressing the same idea as that of Hinsey and Cutting.

In view of these findings, since emotional expression results from autonomic (sympathetic) stimulation, injury to vascular and nerve supplies of the muscles and skin about the nose would alter the power both of voluntary and involuntary movement.

It is Wechsler's opinion that the loss of "effective emotional expression" may be due in part to cutting off the thalamic stimuli. This result would follow if the nerve terminals in the skin and muscles were destroyed or severely injured.

Although Nash<sup>28</sup> states that the function of the sympathetic nerve supply to skeletal muscle is not known, he adds that it can be detected only when muscles are at rest, since it is obscured by any voluntary influence on the muscle. He considers it probable that the sympathetic nerves affect all of the vital processes of muscle cells, partly by direct action upon them and partly by vasomotor influences upon the caliber and the permeability of the capillaries.

To give point to the question which concerns this paper, the following brief case histories are illustrative:

#### CASE REPORTS

CASE I. J. W., male, age twenty-seven, of Irish nationality, had a markedly aquiline nose. The customary operation of undermining the skin was used to reduce the nasal prominence. After an interval of about two weeks following the operation, there appeared a waxy immobility of the tissues in the field of operation. The cosmetic result was otherwise excellent, but after two months the focal facial immobility still persisted in some degree. The patient is conscious of a feeling of stiffness in the tissues, especially when laughing. He is also unable to wrinkle his nose voluntarily.

CASE II. R. S., male, age thirty-eight, an actor, had a deflected nose. There was not

only disfigurement, but also difficulty in breathing. A corrective operation was done, employing the skin-undermining technic. A perfect cosmetic effect resulted, with relief of breathing difficulty. Two weeks after the operation, a condition of limited mobility developed in the facial tissues. This persisted for nine months, but has gradually improved as the result of intensive exercise of the involved parts. This case is one of particular significance, since the patient's profession required the use of a high degree of facial expression.

That facial posture rests upon the integrity of the tissues which are altered in the process of undermining the skin, is supported by the results of the author's modified method of operation, which avoids any of the undesirable complications of reduced mobility of facial expression.

#### AUTHOR'S MODIFIED OPERATION

The method which is employed in operating to avoid the temporary involvement of facial expression is the same as that practiced routinely, up to the point when undermining of the skin is usually begun. Here a straight Joseph's knife is slowly pushed upward through the original incision between the upper lateral cartilage and the skin, until the nasal bones are reached. Then an incision is made in the periosteum at the extreme lower margin of the nasal bone. This incision is accomplished with a McKenty periosteal lever. Very particular care should be exercised here in order to avoid tearing or fraying the periosteal tissue, since periosteal injury may stimulate the hyperplasia of osteophytes (osteoblasts) with resulting osteogenesis. This action can cause serious nasal deformity due to bony overgrowth.

The operation is then continued, using Joseph's periosteal elevator, which is similar to McKenty's, but is somewhat heavier. Through the primary periosteal incision, this tissue is elevated along the bony nasal hump, which is to be removed, up to the nasofrontal angle (glabella). With a careful side-to-side movement of the instrument, as it is advanced, the periosteum is peeled

away from the underlying nasal bones, as old wall paper is separated from a wall. The remainder of the procedure follows the usual method.

In this technic, care is taken to follow the course of Langer's lines, which have already been given emphasis in considering the skin.

Since the muscles are not attached to the nasal bones, but lie over the periosteum and under the skin, the bone fragment can be separated and removed without in any way disturbing either the muscles or the skin.

Following removal of the hump, by elevation of the periosteum only, there has been no appearance of the waxy inelasticity, which has occurred after the use of the method in which the skin is undermined.

It should be added, that special conditions may exist, which indicate a preference for the technic in which the skin is undermined. As elsewhere, this is a question of choice depending upon judgment and experience.

#### SUMMARY

1. A waxy immobility of the tissues about the nose has often occurred after the operation for removal of nasal hump, in which the method of undermining the skin was used.

2. It has been demonstrated that the condition of focal lack of facial motility following removal of nasal hump can be avoided by doing the entire operation by means of periosteal elevation.

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# FAILURE OF CURE OF PELVIC INFECTIONS FOLLOWING THE USE OF PENICILLIN\*

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THE verb "cure" means the successful treatment of a disease, or to heal or restore to health or soundness.

There have been numerous reports recently regarding cure of gonococcal infections with penicillin. These reports have been mainly in cases of gonococcal urethritis in men, and the criteria of cure has been established by clinical and laboratory examination.<sup>1</sup> Even symptoms of salpingitis and pelvic peritonitis have been reported to abate within twenty-four to forty-eight hours following the use of penicillin.<sup>2</sup> Other reports of adnexal involvement in sulfa resistant gonococcal pelvic infection reveal about a 50 per cent rate of cure.<sup>3</sup> Criteria of cure of pelvic infections, mainly gonorrheal pelvic infection, cannot be based on serologic tests of gonorrhea, smears, cultures, and clinical data because the tests are not always dependable, and the clinical data are not always infallible. Therefore, the most dependable test of cure is repeated observation over a long period of time. This period of observation should extend to at least one year, during which time every examination, smear, and culture should be negative. So it is a fallacy to call a person well after three negative smears, and cultures, because of the numerous recurrences that have been reported in the literature and that happen in the practice of physicians.

The following pathogenic organisms, staphylococcus, clostridia, hemolytic streptococcus, anaerobic streptococcus, and the pneumococcus, constitute the next most frequent organisms in the causation of pelvic infections in women. In addition, 5 per cent of all pelvic infections are due

to the tubercle bacillus. Finally, very uncommonly, actinomycosis and bacillary infections as typhoid and the Salmonella groups have been found as the etiologic agents of pelvic infections.

Chronic pelvic inflammation of peritoneal and parametrial tissues leaves its mark on the pelvic organs and is manifested by (1) ovarian dysfunction; (2) pelvic pain due to uterine displacements, contraction of cicatricial tissue and dense posterior adhesions; (3) dysmenorrhea resulting from periadnextis and chronic parametritis with associated varicose pelvic veins.

Fifteen cases of pelvic inflammation in the acute and subacute stage have been studied. They consist of young white females varying in age between twenty to twenty-five, and five are married but nulliparous. All of the patients, according to the history and thorough physical examinations, including pelvic examination that had been performed within one year of the onset of the present condition, were experiencing the first attack of their disease. Urethral and cervical smears and cultures were reported negative at the first examination, and three subsequent smears and cultures were negative at intervals up to four months from the onset of the disease. Treatment consisted of the following in order: Full course of sulfadiazine followed by penicillin. The dose of penicillin varied from 500,000 to 600,000 Oxford units. If no relief of signs or symptoms of pelvic disease followed, two additional courses of penicillin in the same dosage were used. In addition, bed rest,

\* The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

high caloric diet and hematinics, if indicated, were used.

These cases despite the above regime have not responded to the above treatment because symptoms and signs of chronic pelvic inflammation are still present, viz., chronic lower abdominal pain and induration of the parametrial tissues, scarring in the posterior cul-de-sac and inflammatory masses in the adnexal areas.

Gonorrheal infection, staphylococcus, hemolytic streptococcus, or anaerobic streptococcic infections are probably the basis for these pelvic inflammations. Tuberculous infection may be eliminated by exclusion since all cases had negative Mantoux tests and general physical examinations and pertinent x-ray examinations exhibited no evidence of a primary tuberculous process. The typhoid and Salmonella infections may be excluded by stool examination failing to exhibit the causative organism.

According to the co-operative study of Keefer et al.,<sup>4</sup> penicillin is of value in all cases of sulfa resistant gonorrhea and all gonorrheal infections complicated by arthritis, endocarditis, ophthalmia, peritonitis, and epididymitis. Also, its exhibition has been of value in diseases caused by the following pathogenic organisms: staphy-

lococcus, clostridia, hemolytic streptococcus, anaerobic streptococcus and the pneumococcus.

Despite the fact that penicillin has been called almost a specific for the above mentioned pathogenic organisms, its exhibition in these cases has not been attended by complete clinical success which should be manifested by restitution of the involved organs to the normal state. The probable causes of the failure of penicillin may be due to the presence of bacteria which are resistant to penicillin or actually destroy it, or to a morbid anatomical condition that prevents the solution from reaching all parts of the lesion or from persisting there, and finally an antecedent fibrosis mechanically preventing healing.

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# PROSTHETIC RESTORATIONS AFTER AMPUTATIONS ABOUT THE HAND\*

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WAR injuries and industrial trauma have brought amputations and their prosthetic correction again. "working hook" is supplied instead of the artificial hand. Some of these are quite ingenious and useful, but they have a very

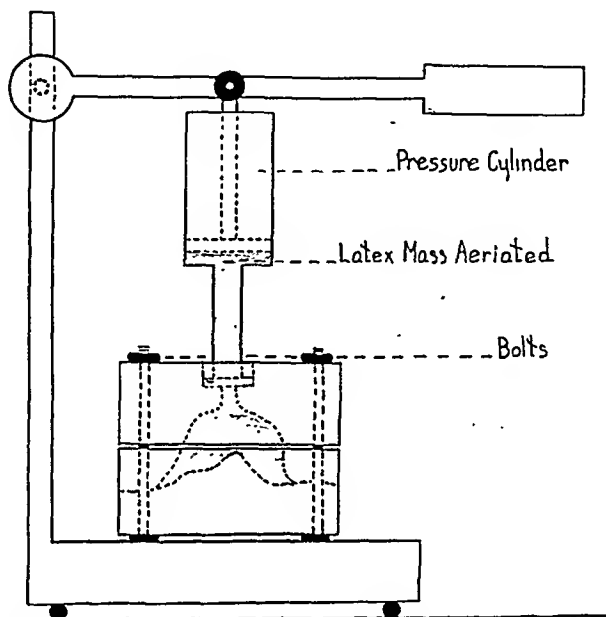


FIG. 1. A pressure gun for extruding frothed or foamed late mixtures into prosthesis mold. Frothed compounds are so light in weight that gravity is of little help in pouring the cast.

to the attention of the industrial, orthopedic, and plastic surgeons. The usual definitive treatment has been: (1) If the entire hand was lost, an artificial hand was supplied. This hand was one of two types: (a) a hand with no movement and (b) an articulated hand. In the artificial limb trade an articulated hand means an artificial hand engineered with the thumb and fingers provided with movement. Whether the patient is supplied with a simple artificial hand or an articulated one, the substitute hand is covered with a leather glove for esthetic reasons. Sometimes a

limited appeal to the patient. (2) If only part of the hand was lost, or if fingers were lost, generally no esthetic restoration was offered to the patient.

The technology of plastic materials, including rubber, has advanced so rapidly in the last few years that now it is possible to make life-like restorations for loss of the fingers or hand. It is also possible to cover a mechanical hand with a life-like surface, simulating the texture and skin tracery, even the fingernails, of the remaining hand.

For such a prosthesis as a finger, or a similar part, which is subject to wear and

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tear, this can often be made of poured molded liquid latex in the form of a hollow shell, especially if only a portion of the

mineral oil, or commercial separating compound. It is then assembled and poured, using alpha gypsum to make a hard plas-

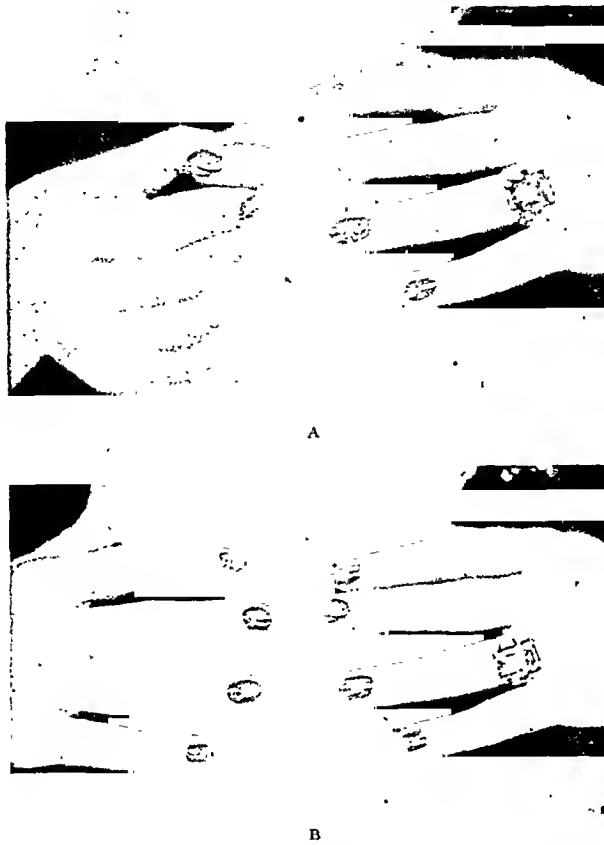


FIG. 2. A, prosthesis for loss of finger tip. Prostheses of this type can be made to fit snugly and securely without adhesives. The fingernail is removeable. B, prosthesis for fingertip; patient wearing prosthesis.

member is missing. For a more extensive prosthesis, it is sometimes advisable to make the prosthesis in such a way that the exterior is made of molded liquid latex in the form of a hollow shell, and the interior is filled with frothed or sponged latex.

A prosthesis of molded latex with frothed rubber filling has these advantages: (1) It is elastic, yet firm; (2) it is not so heavy as a solid rubber prosthesis; (3) it has a life-like feel, and (4) it wears well.

*Technic.* For a prosthesis such as a restoration for a missing finger or missing portion of the hand, an enveloping two-piece negative mold is made of No. 1 molding plaster in the usual way. The impression is first coated with petrolatum,

ter, positive cast of the deformed hand. Upon the hard plaster reproduction of the deformed organ, the restoration is sculptured in clay. It is wise to sculpture the finger so that it is slightly flexed in the normal position in which the hand is at physiological rest. It is not necessary for the patient to pose for this sculpture.

Instead, as a model, a reproduction of the patient's opposite hand is made, in order to have a complete picture of the corresponding finger of the perfect hand in relation to the hand as a whole. From this a negative mold is made as for the deformed hand and is filled with molding plaster. Later the negative is discarded,

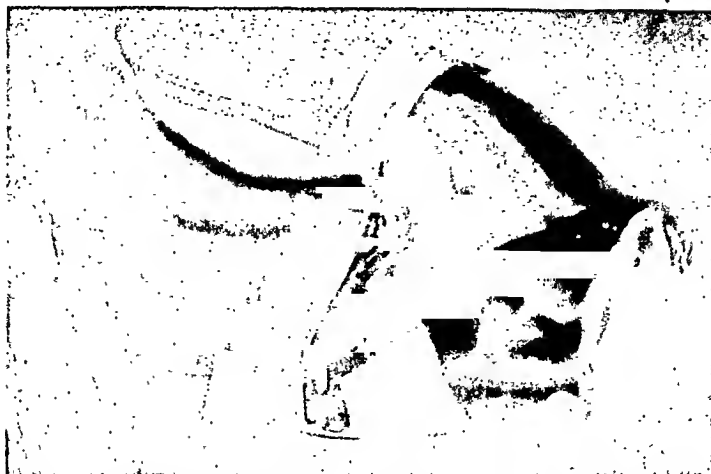


FIG. 3. Artificial hand embedded in plaster. From this negative mold a positive cast will be made and upon it will be designed a life-like cover to replace the leather glove which is usually supplied with an artificial hand.



FIG. 4. Almost total loss of hand. Sculpture completed (Fig. 5 A); note fingernails in position. A clay wall has been built around the sculpture preparatory to pouring a three-piece plaster mold around the sculpture.

leaving a positive reproduction of the "good" hand, or finger, to use as a model.

But the model is not copied exactly. In

artificial nail will fit into this nail-fold, or trench.

The artificial nail remains *in situ* during



FIG. 5. A, loss of almost the entire hand. Artificial limb makers have very little to offer to restore such a deformity. B, same patient with prosthesis. Note wrist watch (bracelet can be used) covers the edge of the prosthesis.

sculpturing a restoration for a missing finger, for example, the restoration in clay must be over-sized for three reasons: (1) To allow for the shrinkage of the rubber; (2) to allow a portion of it to slip sleeve-like over the amputated stump, and (3) to prevent it from appearing "tight," "meagre," or "skimpy."

**Sculpture for the Fingernail.** A major part of the problem at this point is solved in that artificial fingernails are commercially available. A suitable fingernail is selected and trimmed to simulate the remaining nails. During the sculpture of the nail-bed, the false nail is put into place and the nail-fold (or groove in the cutis in which lie the margins and proximal edge of the nail) is sculptured over its edges. When the restoration is finished, the

the pouring of the prosthesis. The first portion of the mold is the positive plaster cast of the reproduction of the deformity (which is now bearing the clay restoration). The two other sections of the mold should each cover portions of the restoration and parts of the positive cast. When thoroughly hardened, the three-piece mold is separated and the clay washed out. The tip of the nail will be found to be imbedded in its proper position in the plaster mold. It is now ready for the pouring of the mold.

In order to obtain maximum flexibility of a prosthesis, the rubber for the interior of the prosthesis may be developed to high flexibility by making it spongy. The latex may be thinned with its usual diluent.

In a prosthesis of this type, the rubber mix for the surface of the prosthesis must



have its coloring adjuncts added before pouring. The colored rubber mix is cast into the mold and permitted to vulcanize



FIG. 6. Three-piece mold used to make prosthesis for end of finger.

for approximately one-half hour. The remaining liquid rubber is then poured off. This will leave a shell of rubber within the mold between one-sixteenth of an inch and one-eighth of an inch in thickness. If the shell is less than one-sixteenth of an inch in thickness, the liquid rubber may be again cast into the mold, and after fifteen minutes poured off again. This process may be repeated until the desired thickness of rubber shell is obtained.

Once the shell of the prosthesis is cast, it is ready for the interior to be filled with a core of frothed latex. A small quantity of latex is poured into a bowl, a commercial frothing agent is added, and it is whipped with a motor driven egg beater until its volume is increased five times. A gelling agent is added, and after a few more minutes of mixing to disperse the gelling agent, the aerated mix is ready to be used in filling the interior of the prosthesis. Once the mix is homogeneously aerated, it is advisable to pour the mold. With rubber of this consistency it is best to use a pressure molding technic. Manual pressure with a piston and cylinder device is sufficient. (Fig. 1.)

The assembled mold for this technic had best be fastened firmly together with furniture maker's clamps or with long stove bolts as illustrated. A minute outlet should be provided to indicate to the technician when sufficient pressure has

been exerted. This is evident when the extruded rubber makes its appearance at the outlet orifice, and shows that the rubber has been injected with sufficient force to insure the most delicate feather edge to the prosthesis. Once this pressure is obtained, the mold is heated at about 180°F. for an hour or two to finish the vulcanizing process.

The pores of the plaster are not necessarily utilized to aerate the rubber. The whipping process introduces enough air to hasten the coagulation of the rubber. The rubber mass is poured into a metal cylinder having a one-inch tube extension. The pressure cylinder containing the colored aerated mix is then placed into position over the flue of the mold, and manual pressure is applied to the piston forcing the liquid sponge rubber into every crevice of the mold. It is now ready for heat vulcanization, if this is desired. This may be accomplished in an oven, or by immersion into boiling water for an hour.

The parts of the mold are then separated and the prosthesis is removed. The artificial fingernail will not come out of the mold so easily as the prosthesis. The fingernail remains imbedded in its trench in the plaster mold. The seams, or flashing, upon the prosthesis is now cut away with manicure scissors and the lines corresponding to where the parts of the mold came together are further obliterated by grinding with a granite dental wheel. A small flashing will be found present along the line corresponding to the cuticle of the nail. This is also trimmed smooth with a small scissors. The nail may now be removed from the mold and inserted in its proper bed at the finger tip. It will fit neatly into the molded trench at the tip of the finger. It may be semi-permanently glued in this position with a gum mastic adhesive, or with the following mucilage: celluloid 25 per cent, acetone 75 per cent. The prosthesis is then ready to wear.

Prosthetic fingers and hands may be fixed into place in several ways. A prosthesis involving the terminal phalanx alone,

can be slipped into place and will stay firmly without a mucilage. A prosthesis for the entire finger generally requires a water-proof adhesive.\* A prosthesis for loss of all the fingers, or to restore most of the hand, should be so made as to reach to the wrist, and it requires no mucilage. The prosthesis is put on in much the same way as a rubber glove is slipped on. The edge of the prosthesis may be disguised with a wrist watch. (See illustration.)

The prosthesis may be washed in soap and water. A patient wearing a prosthesis is advised to remove it when retiring for the night.

For the female patients, when the prosthesis is for the fingers or the entire hand, two sets of artificial fingernails are generally supplied. This is to allow for breakage of the nails and to allow the patient to color the nails if she so desires.

After having made many fingers and hands for people who have suffered amputations, certain conclusions are unavoidable. The average intelligent patient, after having suffered the postoperative emotional shock of an amputation, is usually

disturbed to discover that although his surgery was well done and individualized, restoration for his loss is difficult to obtain on an individual basis. He approaches the artificial limb maker to discover that generally the artificial limb is supplied in three sizes. If his loss is less than a total loss of the hand, the trade has nothing to offer him better than what would amount to a stuffed leather glove.

There is a definite place in plastic surgery for these victims of amputation to obtain a realistic cosmetic restoration for their deformities. For many years, plastic surgery has been more or less the stepchild of the practice of medicine. It has taken two wars for this branch of surgery to obtain a recognized, legitimate place. Likewise, it seems that at the present time plastic surgical prosthetics is the stepchild of plastic surgery itself.

For those doctors who are esthetes, plastic surgical prosthetics, although sometimes an exasperating kind of work, should be of interest. Doctors who are willing to do this time-consuming work, and have a chance to see their creations worn by the patient, will realize they are truly practicing the "art" of medicine.

\* BROWN, ADOLPH M. Correction of facial defects with latex prostheses. *Arch. Otolaryngol.*, 35: 720-731, 1942.



# TRANSVERSE INCISION FOR APPENDECTOMY

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THE ideal incision for appendectomy should give adequate exposure of the ileocecal region, divide fascia and

the wound, and sutures between fibers and in line with them are more likely to pull through than those placed trans-

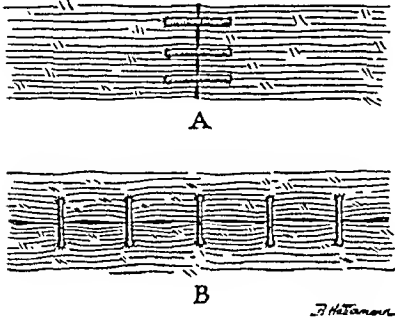


FIG. 1. Diagrammatic sketch showing suture in tissues. The tendency to separate fibers and pull out is greater in (A) where suture strain is in line with component fibers than in (B) where the pull is directed against the fibers.

muscle in line with component fibers, and produce minimal trauma to nerves traversing the area.

McBurney's incision, difficult to enlarge when complications are encountered, and requiring separation of muscle fibers with consequent nerve avulsion, is probably the most frequently used approach for appendectomy. This incision was originally advocated for interval appendectomies only, where no difficulties were anticipated. Certainly it is not ideal for the removal of an appendix situated retroceally, particularly if there has been arrest in the descent of the right colon, leaving the ileocecal junction in the lumbar region.

The right rectus incision is popular, and gives excellent exposure, particularly when freely made. It is easily enlarged. However, fibers of the rectus sheath, transversalis fascia and peritoneum are cut across, which weakens the closure. Any straining on the part of the patient spreads

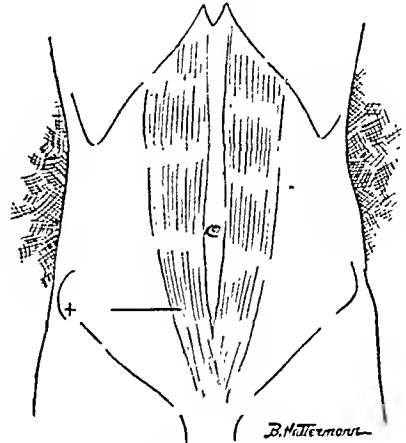


FIG. 2. Landmarks for the transverse incision. Approximately the outer half or one-third of the rectus sheath is exposed, and the incision is made laterally to within 2 or 3 cm. of the anterior superior iliac spine.

versely. (Fig. 1.) If the rectus muscle is retracted mesially, fibers of the tenth and eleventh intercostal nerves, making their entrance to the rectus muscle from a lateral direction, are damaged by stretching. The same is true of nerves supplying the mesial half of the rectus muscle when it is split for a transrectus approach. If the rectus muscle is retracted laterally, in order to spare these nerves, the trauma incident stretching is eliminated, but the incision overlies the abdomen at a point considerably mesial to the appendiceal region. This requires traction for delivery of the cecum.

The midline incision is still farther removed from the ileocecal region, and provides less strength after repair than the rectus incision, producing all the disadvantages of dividing fascia transverse to its fibers, without the interposition of the rectus muscle.

The ideal approach to the celomic cavity for appendectomy is the transverse incision advocated by Rockey and Davis. Orig-

This type of incision opens the abdomen directly over the ileocecal area, and frequently the appendix is visualized as soon

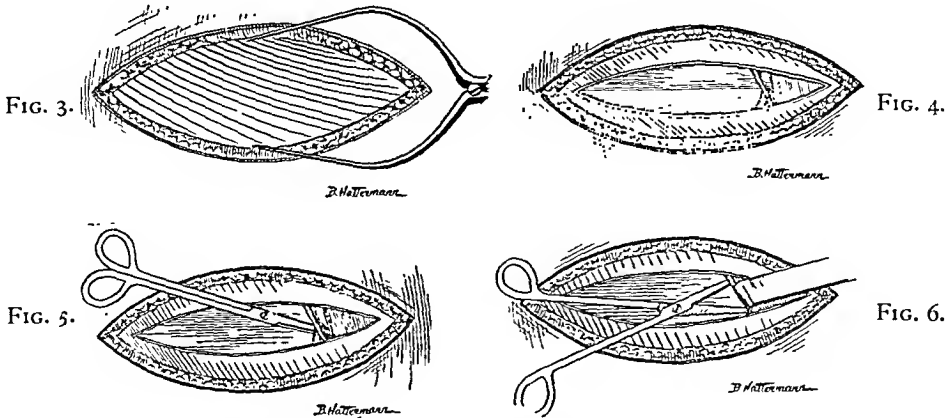


FIG. 3. The skin incision has been made, exposing the aponeurosis of the external oblique and rectus sheath. Note that as the rectus sheath is approached, fibers of the external oblique aponeurosis take a transverse course. Laterally, these fibers incline somewhat cephalad, and have a tendency to retract in that direction when cut. This must be borne in mind as the wound is closed, in order that this leaf may not be overlooked. The Gelpi perineal retractor is in place. Skin towels are omitted from the drawing.

FIG. 4. The rectus sheath has been incised in line with its fibers, exposing the muscle. Note that the component sheets of external and internal oblique aponeuroses tend to separate. As the incision is extended laterally, the twelfth intercostal nerve and its vessels are seen lying between the internal oblique and transversalis fascias. This level is caudad to the semilunar fold of Douglas. The size of the nerve has been exaggerated for clarity. In well developed subjects, muscle fibers of the internal oblique will be encountered in the lateral part of the incision. These run transversely and are readily separated.

FIG. 5. Curved Mayo scissors, point upward, are thrust and spread posterior to the twelfth intercostal nerve, its accompanying vessels, and the rectus muscle.

FIG. 6. As the spread scissors are lifted, a Parker retractor is inserted, and the nerve, vessels and rectus muscle are gently held in a mesial direction. The deep epigastric vessels will easily be seen if they come into the field, and can be avoided.

nally designed to pass transversely through McBurney's point, it has been modified to some extent by Alton Ochsner, who makes a longer incision than the 6 cm. advocated by those who first described it, and who locates it somewhat lower on the abdomen, viz., at the level of the right anterior superior iliac spine. Ochsner's incision is of sufficient length to assure adequate exposure in acute cases, and in interval appendectomies to facilitate examination of the terminal ileum for Meckel's diverticulum, as well as inspection of the internal genitalia in females.

as the peritoneum is incised. The rectus sheath and external oblique aponeurosis to a great extent, and the internal oblique muscle and fascia, transversalis fascia and peritoneum are divided in line with their component fibers. Any inclination of the patient to strain tends to approximate the wound edges. No large vessels are sacrificed, and the twelfth intercostal nerve fibers which traverse this field are easily located and avoided. If necessary, the incision may be readily enlarged by a vertical extension cephalad on the rectus sheath, creating a flap through which

adequate exposure has been provided for cholecystectomy incidental to a mistaken diagnosis.

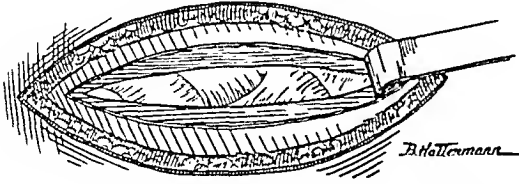


FIG. 7. Division of the peritoneum in line with its fibers, which are transverse, completes the incision. It is not unusual to find the appendix lying in the wound.

The skin incision is made transversely from a point approximately over the center of the right rectus muscle to within 2 cm. of the right anterior superior iliac spine. (Fig. 2.) It is not unusual to encounter less than four superficial vessels requiring ligation. Subcutaneous tissue is divided to provide a clear view of the anterior rectus sheath and external oblique aponeurosis. (Fig. 3.) A Gelpi self-retaining peroneal retractor will be found useful in keeping the skin edges apart.

The fascia is divided in line with the skin incision. As the rectus sheath is incised, the component external and internal oblique fascias will be seen to separate. (Fig. 4.) As the incision is carried laterally in well developed subjects, muscle fibers of the internal oblique will be encountered. These, however, run in line with the incision, and are easily separated. Bleeding will be minimized if the handle of the scalpel is used for this maneuver.

As the fascia at the lateral border of the rectus sheath is divided, care should be exercised to avoid injury to the twelfth intercostal nerve and its concomitant vessels, which run between the internal oblique and transversalis fascias. This is readily seen, and should be included in the Parker retractor used gently to hold the rectus muscle mesially. A pair of curved Mayo scissors thrust point upward and spread beneath the nerve and vessels will facilitate the introduction of the retractor. (Figs. 5 and 6.) As the rectus muscle is lifted

anteriorly and mesially, the inferior epigastric vessels are in full view.

This level is caudad to the semilunar fold of Douglas; hence only transversalis fascia and peritoneum remain to be incised. These structures are picked up and divided in line with the other incisions, viz., in a transverse manner. (Fig. 7.) Enlargement of the peritoneal incision in either direction may be accomplished by tissue scissors under direct vision.

In closing, the peritoneum and transversalis fascia are usually taken as one layer. When the rectus muscle is allowed to fall back in place, it will be seen that much of the incision is covered. DeBakey has made the entire peritoneal opening posterior to the rectus muscle.

It will be found convenient when placing interrupted sutures, to have these cut to fourteen-inch lengths previously. The nurse should have several loaded needle-holders available. As the sutures are inserted, the assistant gathers the ends, holding them in a sheaf. After the necessary number have been put in place, the assistant passes them back to the operator for tying, one at a time, making traction on the remainder. This approximates the wound edges, and greatly facilitates closure. When tying has been completed, the row of sutures is held up and cut directly on the knots, leaving a minimum of thread in the wound.

The anterior rectus sheath is closed in one layer, care being taken that both the external oblique and internal oblique components are included. The cephalad leaf of external oblique aponeurosis has a tendency to retract and may be overlooked if care is not taken. Suturing as one layer continues until the muscle fibers of the internal oblique are encountered. If there has been a pronounced separation of fibers, a suture is inserted and tied loosely. The approximation of the fibers of the external oblique fascia is then continued laterally. At this point the Gelpi retractor and skin towels are removed.

Superficial fascia is easily visualized by everting the skin edges, and is closed with interrupted sutures.

Approximation of the skin completes the procedure. The cosmetic effect, of minor importance from a surgical standpoint, sometimes warrants consideration, particularly in young women. The transverse incision does not directly cross the skin lines of Langer in this region, and a thin scar results unless complications intervene. The belt line is on a level with the iliac crests, and consequently is completely cephalad to the scar, obviating the possibility of friction or pressure.

If drainage of the abdominal wall is indicated, rubber dam tissue may be in-

troduced laterally through the skin incision, and directed in a mesial course to the peritoneum beneath the rectus muscle. This drains the entire incision.

#### CONCLUSION

The little used transverse incision for appendectomy may be made rapidly with little damage to fascia, muscle, nerves or vessels. It produces excellent exposure, and is easily enlarged when necessary. It is readily closed even with the patient straining under a poor anesthetic. Fascial approximation with sutures transverse to component fibers provide a firm repair. The cosmetic effect is gratifying.



An unnecessary appendectomy should not be done during an abdominal or pelvic operation which probably will be followed by some oozing of blood into the peritoneal cavity. A sump drain is routinely advisable if there is a possibility of postoperative oozing both to indicate the presence and amount of oozing and to keep the cavity free from blood and exudate.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# CLINICAL USE OF A RED CELL AMINO ACID MIXTURE AS A SUBSTITUTE FOR WHOLE BLOOD TRANSFUSIONS\*

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IN a British medical symposium on blood derivatives for transfusion, the increasing popularity of red cell suspensions as a therapeutic agent was discussed by military and civilian physicians. Vaughan,<sup>1</sup> Whitby<sup>2</sup> and others claimed that the transfused cells obtained from fresh stored blood "lasted well" in the circulation and that the concentration of hemoglobin was raised as much as 20 per cent from the injection of the cells from one pint of blood. Besides the above advantages, Davidson and Stewart<sup>3</sup> pointed out the economic gain in utilizing the cells available as a by-product of the process of plasma preparation from whole blood. Moreover, in this symposium all were in agreement as to the safety of the intravenous administration of red cells and its therapeutic value for the patient with anemia and sepsis.

In this country also there has been a trend to explore and extend the use of cellular transfusions. Alt<sup>4</sup> reported the case of a patient in refractory anemia who was maintained for one year by infusions of red cells from 25.5 liters of blood. Murray et al.<sup>5</sup> administered 116 infusions of red blood cells and reported only two pyrogenic reactions and no hemolytic manifestations. Evans<sup>6</sup> found that the injections of red cells was especially advantageous for anemic patients resistant to iron and liver therapy.

The search for plasma substitutes has

become an important therapeutic endeavor because of the war emergency. Amino acid solutions from hydrolyzed casein have a proved value as a source of nitrogen for the maintenance and restoration of depleted tissue protein. In shock associated with acute hypoproteinemia the intravenous injection of amino acids has also been reported as beneficial.<sup>7</sup>

In the present investigation the intravenous administration of a mixture consisting of red blood cells, amino acid and isotonic glucose solution was tested. It was used in the supportive therapy, pre- and postoperative for patients ordinarily receiving transfusions of whole blood. The patients were usually in the anemic hypoproteinemic state, both of which conditions are often co-existent. In each case a red cell count, hemoglobin determination, hematocrit cell volume, plasma protein, icteric index and urobilinogen were determined at appropriate intervals.

Red blood cells were available in large quantities and for all types of blood as a side product of the preparation of plasma. The cell mass was kept in its original container (Baxter vaco-liter bottle) after removal of the plasma by suction in the prescribed sterile manner. The average age of the cells in most of the infusion mixtures (60 per cent) was about one to three days. In the rest, older blood (average age four to ten days) was used. Enough

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plasma remained in the bottle to make the material sufficiently fluid to flow readily.

The infusion of cells and solution was given by the two bottle drip method consisting of the container with the red cells and a second bottle a Kelly flask with amino acid glucose mixture. The cellular fluid passed through a mesh filter which retained the buffy fibrinous material. It then passed through a Murphy drip cannula and mixed with the amino acid glucose solution which was also regulated separately by the drip method and a clamp screw. The tubing from each fluid system was connected by a Y tube to a central delivery tube. The entire administrative procedure was simple, involved no extra manipulation and the possibility of bacterial contamination was minimal.

The infusion of the above described mixture and the quantity of its component parts depended on the state of anemia and hypoproteinemia of the patient. The amino acid glucose portion of the mixture served as a supplement to the patient's oral protein intake or was given as the sole nutritive medium to those who were dependent entirely upon intravenous alimentation. For the latter the mixture provided amino acids as a substitute for protein nitrogen and included enough glucose solution to supply at least 1,500 calories. A 15 per cent amino acid casein digest solution with a total nitrogen content of 2 per cent was used. The amount of nitrogen (amino acid) given to each patient varied but was equivalent to 20 to 100 Gm. of protein depending on individual requirements and the discretion of the surgeon.<sup>8</sup> The usual cross agglutination tests prerequisite for blood transfusion were also made. The cellular portion of the infusion comprised the cell mass from 500 c.c. donations of blood. In some cases, two or even three bottles of such cells were given successively.

The mixture was given intravenously a total of 16½ times to thirty-one patients, eighteen of whom had malignancies of the gastrointestinal tract. In ten patients it

served as the sole preoperative infusion medium. Each of seven patients received nine such infusions. It was given also to four patients in shock during and after the stress of the emergency.

Infusion reactions were similar to those following transfusions of whole blood. (Table I.) The occurrence of chills or fever was traced, appeared to be pyrogenic in nature and was attributable to the toxicity

TABLE I  
INFUSION REACTIONS

Kind of Reaction	Incidence, Per Cent
Fever.....	3.8
Chills.....	2.5
Jaundice.....	7.0
Hemoglobinuria.....	0.7

of the anticoagulant sodium citrate. The latter was determined by the methods recommended by Co Tui.<sup>9</sup> Jaundice when it appeared was transitory and was associated with a moderate increase in the icteric index. An elevation of urobilinogen was detected in 12 per cent of the urine samples. Hemoglobinuria occurred on two occasions but disappeared after twenty-four hours.

TABLE II  
SHOWS CHANGES IN THE BLOOD (AVERAGE VALUES) AFTER COMPLETION OF TREATMENT BY THIS METHOD

Blood	Initial Value	Final Value
Erythrocytes.....	2.8 Million	4.3 Million
Hemoglobin.....	47%	81%
Hematocrit value.....	30.1 v. %	41.9 v. %
Plasma protein.....	5.4 gms. %	6.7 gms. %

Improvement in the anemic hypoproteinemic state was obtained in the thirty-one patients. The average, the initial, and the final results are shown in Table II. After each of all but four infusions the red cell count in the recipient usually rose from 50,000 to 215,000 cells per cu. mm. The hematocrit cell volume paralleled the change in erythrocytes and indicated a more normal relationship between the cell and plasma volumes. The increase in hemoglobin averaged between 3 per cent



and 12 per cent after each infusion. The rise in the plasma protein level was variable and generally slow but averaged about 1.3 Gm. per cent. However, the final protein value in slightly more than half the cases failed to reach a concentration of 7 Gm. per cent. This was most apparent in those patients who were sustained solely by parenteral means.

#### COMMENTS

The increase in the red blood cells and the hemoglobin concentration may be accounted for on the basis of stimulation of the red bone marrow and the acceleration in the synthesis of hemoglobin from newly formed globin and available iron. The possibility of the infusion of some free hemoglobin with the cells cannot be denied. Whether due to dehemoglobinization or hemolysis it did not seem to cause any severe reactions other than transitory jaundice and the two instances of hemoglobinuria. It must also be observed that the infusion of the cell mass from 500 cc. of blood in itself actually represented an addition to the patient's blood of about 75 Gm. of protein in the form of hemoglobin. However, the present studies confirmed the claim of Ross and Chapin<sup>10</sup> that the infusion of red cells regardless of their survival time in the blood was an excellent therapeutic agent superior to any hematopoietic drug.

The slow rise in the plasma protein level may have been due to the synthesis of hemoglobin and the replenishment of indispensable protein taking precedence over other forms of protein regeneration.<sup>11</sup> This slow rise may also be accounted for on the basis of infection or metabolic disease<sup>12</sup> which could have retarded the return of the plasma proteins to normal. Although the plasma protein level was not restored to normal in all cases, there were

clinical indications of improvement such as gain in weight and satisfactory wound healing. Bassett and others<sup>13</sup> have had a similar clinical experience and concluded that the use of intravenous amino acids satisfied nitrogenous requirements and stimulated the formation of body protein.

The four patients in shock reacted well to the red cell amino acid mixture. This response may have been due primarily to the red cell and the increased oxygen-carrying capacity of the blood. However, Elman and Lischer<sup>7</sup> have observed that amino acid solutions injected into animals in hemorrhagic shock exerted a favorable effect on the survival time similar to that obtained with the use of plasma.

#### SUMMARY

1. A mixture of blood cells, amino acids and isotonic glucose solution was found to be of general therapeutic value as a substitute for whole blood transfusions.

2. The cellular mass remaining after separation of the plasma from whole blood can be used advantageously.

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## BRIDGE OPERATION FOR DUPUYTREN'S CONTRACTURE\*

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DUPUYTREN'S contracture of the hand is a curious disease first described by A. P. Cooper and

been reported in which endocrine dysfunction is present, while others have been noted in connection with diseases of the

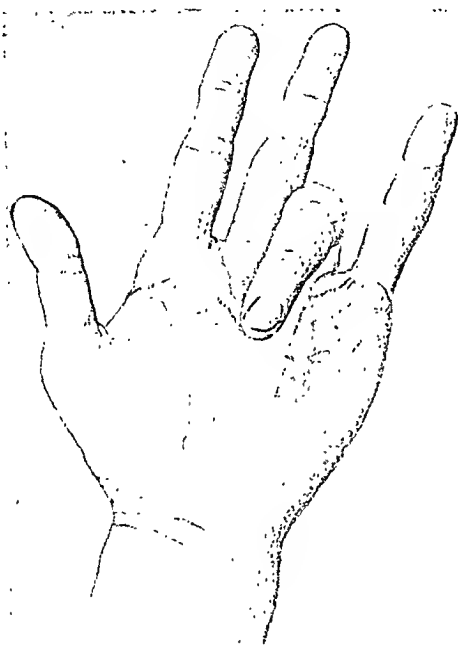


FIG. 1. Case of Dupuytren's contracture illustrating position of the finger.

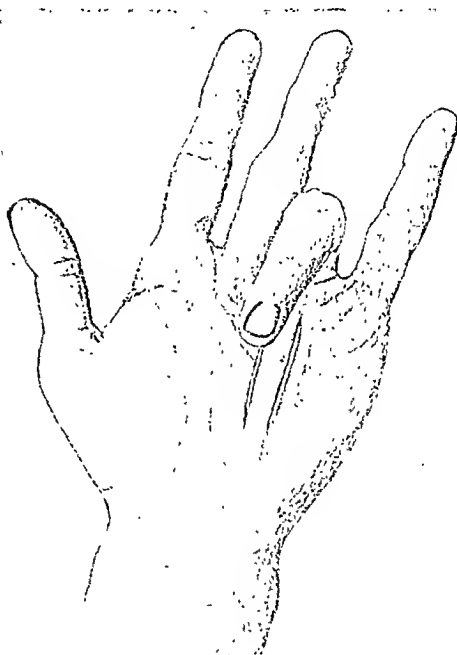


FIG. 2. Longitudinal parallel incisions have been made along the edges of the contracture.

later, in 1831, more completely described by Dupuytren, who called it "permanent contracture of the fingers."<sup>1</sup> It is characterized by chronic thickening and hypertrophy of the palmar fascia with formation of linear bands to one or more fingers, resulting in deformity of the hand and impaired function. We will describe very briefly the principal features of the disease and present a simple operation that we have found satisfactory in selected cases.

The cause of this contracture is obscure. It has been attributed to hormonal and nervous disturbances, to inflammation of unknown origin, and to trauma. Cases have

central nervous system. Lund<sup>2</sup> has noted its frequency in epileptics and has stressed possible hereditary causes. An inherent susceptibility to inflammation of fibrous tissue has been advanced as an explanation.<sup>3</sup> We and others have noted an apparent relation to trauma in many cases. Most of our patients are seamen engaged in heavy manual labor and their hands are subjected to frequent and repeated injury. Some of them gave a history of a single injury to which they attributed the onset of the deformity, but others noted the condition for the first time when it was mature, and could recall no trauma.

\* Approved for publication by the Surgeon General, U. S. Public Health Service.

The disease usually begins in the ulnar half of the palm and affects the ring and little fingers most frequently. Sometimes

ture often does not progress to joint involvement but may remain for years stationary with little resulting disability.

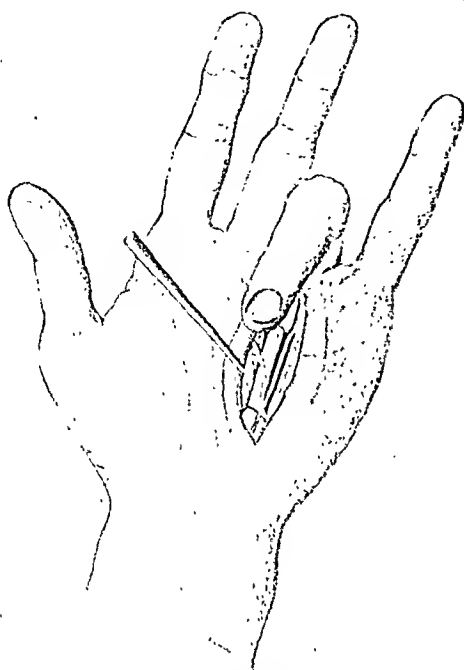


FIG. 3. The bridge consisting of skin and diseased tissue has been raised.

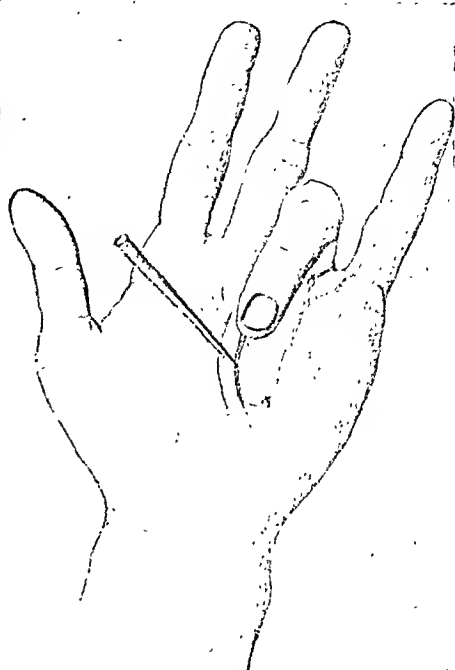


FIG. 4. A graft has been placed beneath the bridge.

it involves all the palm and all fingers. It is often bilateral and symmetrically placed. Thickening begins in the palmar fascia, usually in a localized area at the base of a finger where a subcutaneous nodule may be formed. Thickening extends from the skin and subcutaneous tissue through the palmar aponeurosis to the tendon sheaths but rarely involves the tendon proper. The process extends progressively and insidiously until the palmar aponeurosis becomes replaced by diseased fibrous tissue. Extension into the digital slips occurs frequently. Retraction of diseased tissue results in puckering of the skin, more nodule formation, and flexion deformity of the fingers. (Fig. 1.) The digits are first flexed at the metacarpophalangeal joints and later the interphalangeal joint may become involved either through disease or disuse so that therapy is of little avail. The disease having thus begun in one palm may appear in the other or may appear simultaneously in both. A given contrac-

Although this condition is admittedly insidious and slowly progressive, it is remarkable how some men become adjusted to it and are reluctant to seek relief. Some of our patients presented themselves for treatment only after having been refused employment on the basis of resulting disability, then in advanced state. Since the cause is unknown and the course variable, it is difficult to predict the course in an early case. But since severe cases of long standing may be difficult or impossible to correct surgically, we have tended to favor early treatment if any limitation of extension of a finger is present.

For treatment of Dupuytren's contracture, radiation, physiotherapy, and operative procedures have been advocated. Volavsek<sup>3</sup> and Feurstein<sup>4</sup> report good results with radium emanations in a small number of patients. Formerly, massage, local heat, and passive exercises were used, but in our experience they have been useless. Many earlier writers and most recent

ones agree that operative relief is the only means of cure. Dupuytren himself recommended excision. Most authors recom-

date, when the graft has taken, the diseased bridge is excised. This operation cannot be used for all types of the disease

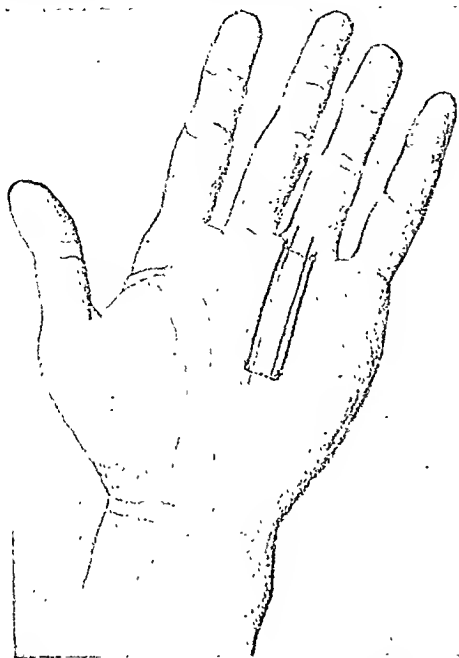


FIG. 5. Diagrammatic representation illustrating extension of the finger and bridge holding pressure on graft.

mending operation have emphasized that the diseased fascia must be excised in its entirety, either by subcutaneous dissection through one or more transverse incisions or by excision of the fascia and closely adherent skin intact.<sup>5</sup> Skin grafts are often used to cover defects created by complete excision or to replace non-viable flaps. Skinner has advocated complete dissection of the fascia from the skin and use of a tunnel graft.<sup>6</sup>

Dissecting the diseased palmar fascia in its entirety and freeing it from the closely attached skin is a time-consuming and tedious procedure. In order to avoid this we have attempted to perfect a simpler method. In the "bridge operation" described here, the contracture, together with its overlying skin, is lifted *en masse* and a graft applied beneath. After raising the bridge, extension of the finger is possible in properly selected cases, and such extension causes the bridge to exert firm even pressure on the graft. At a later

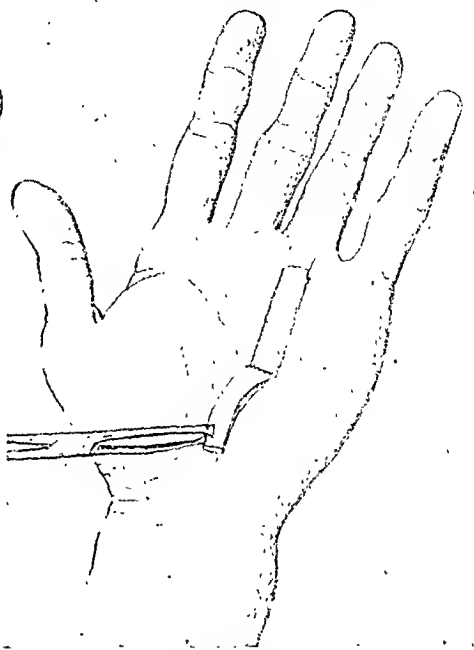


FIG. 6. The distal part of the bridge has been cut away leaving the healed graft in place. The proximal end will also be cut away and the raw edges of skin stitched to the graft. This stage of the operation may be performed under local anesthesia, using a few drops at each end of the wound.

but is most useful where there is a single band of contracted fascia limiting extension of one finger, as shown in the figures. It may be used for more than one finger if each is limited by its own individual band; but if great extension and fixation of the joints has occurred, this procedure is useless.

The patient should be in good general condition and the skin everywhere free from infection. The hand and forearm are prepared by scrubbing with soap and water and by washing with saline solution and ether. A blood pressure cuff tourniquet may be used. The hand and forearm are draped to the elbow. Parallel longitudinal incisions are made on either side of the contracting band (Fig. 2) and are extended proximally and distally until they enter normal tissue. The incisions are beveled

inward slightly. A bridge of tissue connected to normal skin at its proximal and distal ends is then created by undermining

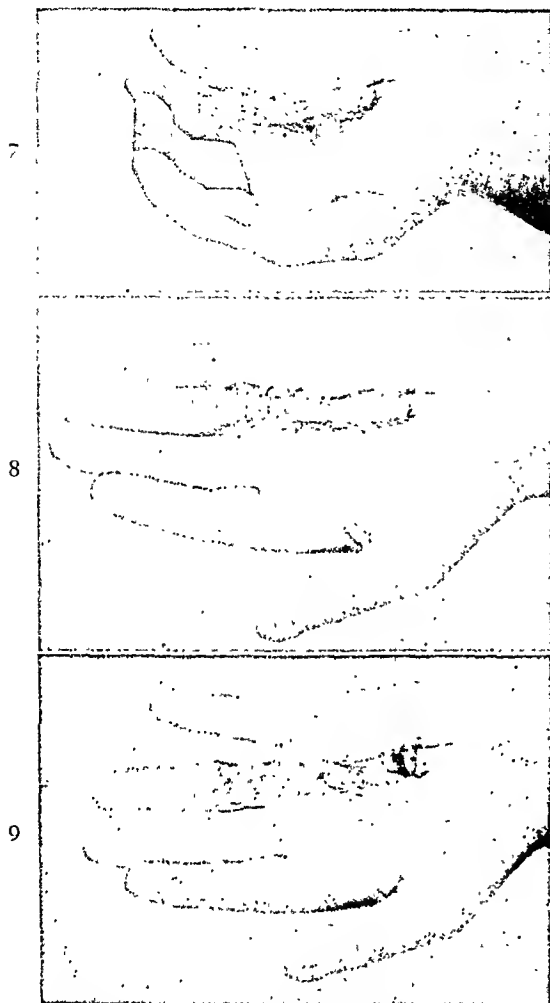


FIG. 7. The bridge of diseased tissue is shown with the edge of the graft visible on the radial side beneath.

FIG. 8. Extension of the finger is possible even though transverse division of the contracture has not been made. Necrosis occurs in center of a long bridge. Case shown at time of first dressing ten days after operation.

FIG. 9. Tenth day postoperatively; the bridge has been excised.

the diseased fascia, together with its skin, between the two parallel incisions. (Fig. 3.) In this dissection digital vessels and nerves may be encountered and must be preserved. When the bridge has been made, extension of the finger is possible although no transverse division of the contracture has been made. The tourniquet is loosened and hemostasis is secured. A suitable donor

site is selected (the forearm is already draped and available) and a free graft is cut. A full thickness graft may be used and the donor area closed, or a thick split graft may be cut from the thigh with a dermatome. A full thickness must be accurately fitted to the defect but a split graft may overlap. The graft is inserted beneath the bridge and may be secured with a few fine silk stitches although suturing is not necessary. (Fig. 5.) Dressings are applied and the fingers are splinted in extension. At the end of ten days to two weeks the graft should have taken. Under local anesthesia the bridge of tissue is divided from its proximal and distal connections (Fig. 6) and the graft is sewed to the new skin edges at each end. The splint need not be reapplied, and the patient is encouraged to begin active exercise. The following is an illustrative case:

#### CASE REPORT

E. E., a merchant seaman, age 55, No. 62191, was admitted for treatment of limitation of extension of the left fourth finger. The general examination showed no abnormalities but local examination of the hand showed "a flexion contracture of the ring finger. On attempted extension a rigid cord-like band stands out on the palm, leading to the base of the finger. It feels somewhat knobby and irregular. Extension is limited to about 135 degrees." The diagnosis was early Dupuytren's contracture involving the left ring finger. For this case the bridge operation was employed, using a free full thickness graft. The graft healed kindly, losing superficial layers of skin in two areas. Figures 7 and 8 illustrate the appearance of the wound at the first dressing on the tenth day. The bridge with underlying graft is shown. Figure 9 shows the appearance of the graft after excision of the bridge. Extension of the finger is complete.

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# THE RESPONSE TO PREOPERATIVE IRRADIATION AS A CLUE TO THE MANAGEMENT OF BREAST CANCER\*

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THE rôle of radiation in the treatment of breast cancer is a controversial one.

The value, or lack of value, of preoperative irradiation has not been established despite the large amount of literature and the clinical experience that has accumulated. Even the term "preoperative" seems to have no definite meaning. It has included all technics, from doses so small as to be almost homeopathic, to amounts so large that grave damage has been done, and serious sequelae have resulted. Some have used it only to modify the most sensitive cells before surgery, while others have attempted a cure with irradiation alone.

The present article is an attempt to clarify one phase of the enormously complex problem of cancer of the breast. In 1938, Coutard<sup>1</sup> pointed out that "technical operability does not necessarily mean actual operability." He emphasized the great gap that might lie between technical operability and biological operability. Surgery, Coutard maintained, achieved its best results in the relatively insensitive tumors. It was he who suggested irradiation be used as a means of distinguishing these types.

This seems not to have met with any general acceptance. Indeed Adair<sup>2</sup> dismisses preoperative irradiation on such grounds as "... the morbidity (from radiation therapy), poor wound healing, and fibrosis of the lung." He also writes that "only 35% of the cancers located in the breast proper were sterilized (sic) by modern divided dose methods." This reveals a quite different attitude toward the function and desirable amounts of pre-

operative irradiation than that held by O'Brien,<sup>3</sup> Bell, Edson and Hornick<sup>4</sup> Dann and Koritschoner,<sup>5</sup> and others.

O'Brien<sup>3</sup> has well summarized the situation: "Following literally the method employed by Adair, one would have to expect the untoward results described by him, but it should be recalled that he purposely used large doses of intensive radiation to obtain data on the cancericidal effect of X-Rays on the tumor in the breast and axillary nodes." O'Brien, as well as others, including the author, doubt that "sterilizing" doses are "either desirable or necessary."

The present report is an attempt to determine if Coutard's clinical impression is borne out in a series of unselected patients. During the period of 1938 to 1944, 131 cases of proven breast cancer were given preoperative irradiation in the Radiology Service of the Los Angeles County Hospital.

The customary daily dose was 300 r (in air) given through a 10 by 10 cm. supra-clavicular and to each of two opposing breast portals (usually 10 by 15 cm.) for a total of 1800 r each. The axillary field (10 by 10 cm.) received 1500 r. The factors were, 200 K.V., 50 cm. T.S.D., Cu. 0.5 mm., plus Al. 2 mm., H.V.L. 1.0 Cu. The intensity was 35 r per minute.

The skin effect of this program was seldom more than a brisk dry erythema. The operative procedure was performed four to six weeks later.

The tumors of fifty-three (33 per cent) of these patients underwent striking regression under this treatment. That is, there was such a marked diminution in the

\* From the Tumor Board and Department of Radiology, Los Angeles Therapeutic Hospital.

size of the mass that it was noted as being only "an indefinite thickening" or "no palpable tumor." Of these fifty-three patients, twenty-nine (54.7 per cent) then had radical mastectomies, while twenty-four (45.3 per cent) had no subsequent surgery.

In this hospital our follow-up is far from ideal. The natural history of breast cancer being as capricious as it is, added to the difficulty of an assay of our results. It was decided to use for this study, as the single point of reference, the time interval after the start of irradiation to the development of recognizable metastasis. It is realized that some of these patients may never develop metastases but, nevertheless, the results are rather striking.

The following cases have been followed for periods ranging from six months to six years:

TABLE I  
SURVIVAL OF IRRADIATED PATIENTS HAVING RADIO-SENSITIVE CARCINOMA, WITH AND WITHOUT SURGERY\*

Surgery	No. of Cases	Survivals	Survivals, Per Cent
Radical mastectomy.....	29	11	45
None.....	24	14	56

\* There were no deaths immediately attributable to the surgery.

TABLE II  
AVERAGE TIME AFTER TREATMENT TO THE APPEARANCE OF METASTASIS IN IRRADIATED PATIENTS WITH RADIOSENSITIVE CARCINOMA, WITH AND WITHOUT SURGERY

	Months
Irradiation plus radical mastec- tomy.....	10.77
Irradiation alone.....	16.22

The above data are not materially affected by the comparatively small number of cases and length of their follow-up. No consistent correlation was found between the histology and the radiation response.

From the above it appears that there is evidence to support the belief that in highly radiosensitive breast tumors, Stages

II (i.e., with axillary adenopathy) and III (i.e., with skin involvement), surgery is prone to disseminate the disease with the earlier appearance of metastasis. These data are the more remarkable in view of the fact that the patients having "preoperative" irradiation but no subsequent surgery, were in much poorer general condition than those who were operated upon. Indeed, it was only debility that prevented their having radical surgery.

None of this makes us believe that irradiation offers a happy future for these patients. However, it does lead us to the conviction that the surgical results in this group of radiosensitive tumors are apt to be particularly unfortunate.

In view of the foregoing support of our long standing clinical impression, the following outline has been adopted by the Tumor Board of this hospital:

PLAN FOR THE MANAGEMENT OF BREAST CANCER

- Stage I. Localized in breast.  
Immediate radical surgery, unless specific contraindications exist:
  - (a) Pregnancy
  - (b) Lactation
  - (c) Grave systemic disease
- Stage I. Clinically but Stage II Pathologically:  
Postoperative irradiation as soon as possible.
- Stage II. Metastasis to axillary nodes.
- Stage III. Involvement of skin of breast.  
Preoperative irradiation for a period of not to exceed two weeks.
  - (a) If the tumor mass shows very little regression at the end of this period, the patient is then to have immediate radical surgery followed by postoperative irradiation.
  - (b) If the tumor shows marked radiation re-

sponse at the end of the two-weeks period, preoperative irradiation is to be continued and if, after irradiation has been completed and a suitable time interval has elapsed, a residual mass remains in the breast, the patient is to have radical surgery.

- (c) If, at the end of the "preoperative" irradiation, there remains in the breast no palpable evidence of tumor, the patient is to have no subsequent surgery.

*Stage IV.* Fixation of lesion to chest wall. The treatment of these patients is to be considered individually by the Tumor Board.

*Stage V.* Distant metastases, to lungs, bone, liver, etc. Treatment either by irradiation

or medical palliation, as the case may require.

It is understood that unusual cases shall be considered individually by the Tumor Board, and that the above policy may, in special instances, not be followed rigidly.

#### SUMMARY

1. A series of 131 cases of breast cancer have been studied to determine if the response to preoperative irradiation gives any clue to their best management.

2. Irradiation as the sole therapeutic agent in cases of highly sensitive breast tumors appears to delay metastasis.

3. Our present plan of classification and treatment for breast cancer is presented.

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# Case Reports

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## MIKULICZ'S DISEASE\*

### A REPORT ON A PATIENT TREATED WITH PENICILLIN

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TRUE Mikulicz's disease is rare. The literature contains reports of many cases simulating the disease described by Mikulicz, but it is questionable whether they should be classified as such. In the session of January 23, 1888, Mikulicz presented the first description of this disease before the Society for Scientific Medicine at Königsberg. His case presentation was as follows:

"Both lacrymal glands and all the salivary glands were changed in a symmetrical manner into tumors, which pushed themselves markedly forward from the normal position of these organs and thereby distorted the physiognomy of the patient in a remarkable way. The tumors had arisen gradually; they were at the time of examination of a hard consistency, painless, without trace of inflammatory signs. Moreover, elsewhere there were present no pathological changes in the bearer of these tumors . . . I found not a single observation similar to mine recorded in the literature . . . Seven months previously, in June 1887, he noticed that both upper eyelids began to swell; he had no pain or other trouble, except that with the increased swelling, opening of the lids was rendered difficult. Later the palpebral fissure became so much narrowed that it was difficult for him to see. Soon afterward there appeared under both angles of the jaw, similar painless swellings, which as they grew larger, interfered with eating and speaking . . . In the blood there is

no striking change, especially no leukocytosis . . . The countenance appears strikingly altered because of the symmetrical swelling in the region of the upper eyelids, the parotid and the submaxillary glands. The upper eyelids hang down so far, especially in their outer halves, that the palpebral fissure is reduced to a narrow, triangular space, with base formed by the inner two-thirds of the lower lid . . . the patient is unable perceptibly to raise the upper lid himself, even with strong effort . . . Under each angle of the jaw projects a tumor about the size of a hen's egg, covered by normal, moveable skin . . . If the patient opens his mouth, attention is drawn at once to tumors corresponding to the two sublingual glands . . . During the examination, a copious secretion of saliva takes place, but there is otherwise no sign of salivation existing."

This detailed description of the disease, which has been named after the surgeon who so clearly portrayed it, like many classical descriptions, has never been improved upon. The powers of observation of scientists of past generations seem to have been more highly developed and their descriptions more minute and painstaking.

It is obvious from a study of the literature that some of the authors either were not familiar with this classical description by Mikulicz or that they considered this observation to cover a wide field. Consequently, we find that many cases have

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been reported under the title of Mikulicz's syndrome and include leukemias, tuberculosis, syphilis, etc. Finally, Shaffer and Jacobson presented the following classification:

1. Mikulicz's Disease
  - (a) Familial
  - (b) Mikulicz's disease proper
2. Mikulicz's Syndrome
  - (a) Leukemia
  - (b) Tuberculosis
  - (c) Syphilis
  - (d) Lymphosarcoma
  - (e) Toxic
    - (1) Lead
    - (2) Iodides, etc.
  - (f) Gout
  - (g) Febris uveoparotidea subchronica

This classification surely includes many diseases of the neck. But to me it is confusing and misleading, and I do not believe Mikulicz had anything like this in mind when he presented his classical description.

Rather I think we should look upon Mikulicz's disease as one characterized by a benign, symmetrical, painless enlargement of the salivary and lacrimal glands, a normal blood picture and frequently accompanied by a soreness and dryness of the mouth and tongue. Obviously cases including an abnormal blood picture, as the leukemias, and those including changes in the lymphatic glands, as tuberculosis, should not be included. It is true that involvement of the lacrimal and salivary glands may occur in leukemia but as such is merely a local manifestation of a general blood disease.

Dixon believes that syphilis is the primary cause of Mikulicz's disease and reported a case showing response to antiluetic treatment. However, syphilis has not been found to be the etiological factor in most of the reported cases nor was that true in the case herein reported. Rather I would think that the occurrence of syphilis in Dixon's case was merely coincidental and that improvement might either have been spontaneous, as some-

times occurs, or the result of iodide therapy.

Mikulicz believed that he was dealing with an infectious disease, and no one has ever disproved this theory. On this basis the patient in the case which I am reporting was treated with penicillin although in a number of instances favorable response has been reported from x-ray therapy. It is possible that the disease might extend from the salivary glands to the lacrimal by way of the nasolacrimal duct since the mucous membrane of the mouth is continuous with that of the conjunctival sac. The conjunctivitis noted in my case would seem to corroborate this original idea of Mikulicz's. Fever, however, is not characteristic but has occasionally been reported to occur.

This disease may occur at any age but is most common in early adult life or in middle age. Howard, studying a series of forty-one cases of true Mikulicz's disease collected from the literature, found the youngest patient to be five and one-half years of age and the oldest to be seventy-seven years of age. The average age of this series was thirty-three. The series showed the disease to be more common in the male, the ratio being 26 to 15.

The most striking features of the disease as it appeared to me were the peculiar appearance of the face with the narrowed palpebral fissure, the symmetrical enlargement of the salivary glands, and the parchment-like dryness of the tongue. This characteristic triad of symptoms should enable one to establish a diagnosis quickly and easily of this rare condition.

Eyesight is not disturbed as a rule unless the tumor mass is so large as to make it difficult for the patient to open his eyes.

The general health of the patient is good in marked contrast to most disease conditions of the neck and mouth. On the other hand, the lack of saliva causes considerable discomfort in the way of mastication of food, swallowing, singing, etc.

The prognosis is variable. In some of the reported cases the condition persisted for

months or even years with periods of remission and then finally subsided.

Various methods of therapy have been

In recent years deep x-ray therapy has yielded successful results, and reports of patients so treated have been made by

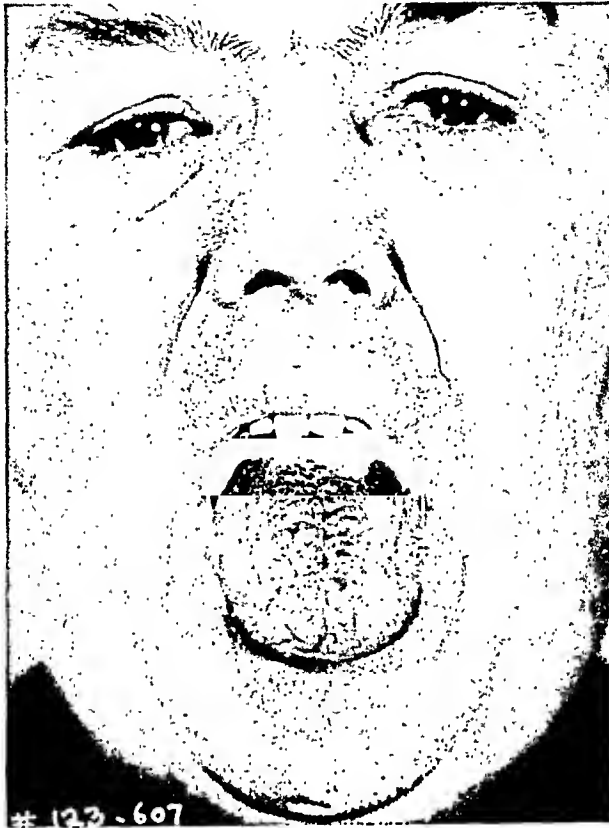


FIG. 1. Mikulicz's disease. Note the parchment-like dryness of the tongue, the swelling of the salivary glands, and the narrowing of the palpebral fissures.

tried including surgery, x-ray, iodides, etc. As far as I know, the case reported here is the first in which penicillin has been tried. I could find no reports of the use of the sulfonamides although my patient had been unsuccessfully treated before being referred to me.

Smith reported operating upon a patient in 1924 and removing the left submaxillary gland. He believed this to be malignant and followed the operation by deep x-ray therapy. However, a year later the tumor returned. At this time both parotid glands were removed, and a diagnosis of Mikulicz's disease was established by Le Count. The patient experienced no further trouble. Cure was likewise established by surgery in the case reported by Lehman and Leaman.

Pfeiffer, Evans and Leucutia, Hodges, Wright, Hamilton, Pohle, Miller and Eusterman. Two patients were successfully treated with radium by Pinch.

Arsenic and iodides have been tried with varying success. Some of the cases that responded were undoubtedly true cases but belong in the syndrome group being luetic in origin.

The pathological picture is typical, the true glandular tissue being replaced by lymphocytes either in section or throughout the whole section. Connective tissue may be marked in some cases and is probably an indication of a more advanced state. The process appears to represent a chronic inflammatory one although it is believed by some observers to be indicative of a benign neoplasm. Boyd is of the

opinion that the condition may be regarded as a localized form of lymphoblastoma. Ewing's conception that the cervical and axillary nodes, spleen and liver are often involved in the later stages and that many of the symptoms resemble those of Hodgkin's disease is certainly in contrast to the classical picture of Mikulicz's. Miller and Eusterman take exception to the assumption held for years that the disease in the original case of Mikulicz's was benign and self-limited. To them this view hardly seems tenable since lymphoid tissues may diminish in the presence of an overwhelming infection and dehydration such as Mikulicz's patient must have had. In their opinion there will always be some doubt as to the ultimate diagnosis in Mikulicz's original case as the patient died of peritonitis from "perityphlitis" just two months after the second excision of recurrent lacrimal tumors and fourteen months after the onset of the illness. During the nine days of the terminal illness the swelling of the parotid glands practically disappeared. Because the histologic picture in the orbital nodule removed for biopsy in the Miller-Eusterman case was almost identical with the histopathologic findings described in Mikulicz's original case, they question whether his case was actually a benign self-limited process. In a further discussion of the subject from a roentgenological standpoint, Leddy states that Mikulicz's disease is best regarded for purposes of roentgen treatment not as a specific entity but rather as a manifestation of lymphoblastoma.

#### CASE REPORT

Mr. C. M., aged fifty-two, came to the Jackson Clinic on August 21, 1944 complaining of extreme dryness of the mouth and lumps on his neck which he had first noted three weeks previously. He thought it had begun when he yawned and the muscles of his neck seemed to tighten. The following day he noticed the glands of his neck were swollen, and he called his local physician, who gave him a sulfa drug with no apparent improvement. Two weeks prior to his coming to the clinic the saliva

stopped flowing, and he consulted other physicians who tried various remedies including hypodermic injections, electric treatments, mouth washes, etc., without success. The swelling of the glands increased to such an extent that he found it very difficult to open his mouth; his eyes were nearly swollen shut and his voice, likewise, was affected.

On examination, general physical findings were normal except for the following: There was a rather marked enlargement of the sublingual, submaxillary and parotid glands. The enlargements were smooth and not tender but sufficiently large to interfere with speaking and eating. "There was symmetrical swelling in the region of the upper eyelids. . . . The upper eyelids hung down so far, especially in their outer halves, that the palpebral fissure is reduced to a narrow, triangular space with the base formed by the inner two-thirds of the lower lid. The patient is unable perceptibly to raise the upper lids himself even with strong effort."

On first examination the patient was able to open his mouth only enough to see the tongue with some difficulty, but after a few days treatment he was able to open his mouth sufficiently so that one could see the tongue characteristic of the parched dryness of Mikulicz's disease. His voice had a husky note. Because of the dryness of his entire mouth he said his diet was almost entirely liquid. His temperature was 99.6°F. Urinalysis and blood count as follows: specific gravity 1.010, reaction acid, sugar negative, few red blood cells. Hemoglobin 81 per cent, erythrocytes 3.99, leucocytes 10,550, lymphocytes 15, large mononuclears 4, transitionals 3, neutrophils 76, eosinophiles 2. X-ray of the submaxillary areas: "Roentgenograms of the parotid and submaxillary areas revealed no evidence of salivary calculi."

The complete picture suggested an acute stage of Mikulicz's disease with the typical enlargement of the salivary glands, absence of saliva, conjunctivitis, and narrowing of the palpebral fissures, the painless, non-tender glands which were firm and smooth and not adherent to the surrounding structures and the ptosis of the eyelids. His general health was good except he found it impossible to masticate.

A review of the literature revealed that there was considerable conjecture regarding the classification of cases of true Mikulicz's disease

and those considered under the Mikulicz's syndrome. Some cases had responded to surgical treatment, others to x-ray therapy. I was unable to find a report on any patient successfully treated with the sulfonamides. Although the etiology of the disease has remained a mystery, in many ways it suggests a low-grade infection of the salivary ducts. Therefore, it was decided to try penicillin therapy. He was given 100,000 units diluted with 20 cc. of sterile, physiological saline solution. He was given 5,000 units per cc. concentration each twenty-four hours, the dosage being 2 cc. intramuscularly every three hours night and day for seventy-two hours. Treatment was started August 22nd and on August 25th the patient noted that saliva began to flow and that the glands were rapidly receding. He was able to open his mouth wider, could eat solid food, chewing meat, etc., for the first time in four weeks. The conjunctivitis was receding also. In view of the mild, secondary anemia which was present, he was given Kapseals Ventriculin with iron and vitamin B capsules, one three times daily.

On September 5th, it was noted that the salivary glands were nearly normal in size and there was a further improvement in the eyes but the tongue seemed drier. He was re-admitted to the hospital and was given another 100,000 units of penicillin. On September 9th his condition generally seemed to be improved, but it was noted that there appeared to be a cycle of three or four days' duration when the tongue was dry, then becoming moist again. Further improvement of the eyes was noted, and he no longer complained of a burning sensation. Because of the intermittent flow of saliva it was decided that he be given a course of radium over the region of the left salivary glands. He was given a dosage of 350 mg. hours over two areas and was to return for further treatment of the right salivary gland area in three weeks but reported that he had so sufficiently improved that he did not think it necessary.

It is not possible to say conclusively that penicillin effected a cure in this case as sufficient time had not elapsed before the use of radium. It is certain that the swelling of all the salivary glands and conjunctivitis had subsided before radium was used and that the flow of saliva had commenced so that he was able to open his mouth fully and properly masticate solid food.

On November 2, 1944, the patient reported that the flow of saliva is normal except when he awakens in the morning, that his eyes have entirely cleared up and that he is now working six days a week and feeling very well. He is able to eat beef steak, tenderloin steak and enjoy it. He has rejoined his singing group and is able to carry on normally in that respect.

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# SOLITARY DIVERTICULITIS OF THE CECUM

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**S**OLITARY diverticulitis of the cecum is an uncommon lesion as judged by the few cases reported. The lesion in the majority of cases is preoperatively diagnosed as appendicitis. It is frequently a difficult lesion to diagnose at the operating table and is most commonly mistaken for carcinoma of the cecum with the result that radical surgery is performed.

In 1943, two articles appeared in American literature with case reports, reviews of the literature, and analytical studies of diverticulitis of the cecum.<sup>1,2</sup> Only those cases of solitary diverticula are included in this report. A few cases have been recorded in which there was inflammation of a single diverticulum of the cecum in the presence of other non-involved cecal diverticula. In these instances the pathological process was the same as in true solitary diverticulitis. The symptoms were characteristically those of an acute inflammatory lesion of the right lower quadrant. Baker and Carlile<sup>2</sup> found thirty-seven cases of true solitary diverticulitis of the cecum in the American and British literature and added two of their own making a total of thirty-nine in their series. They<sup>2</sup> did not include the six cases of solitary diverticulitis reported by Schnug in their series. We have in the past year encountered three cases. The addition of these nine cases brings the number reported to forty-eight.

Diverticula of the colon are classified as either true (congenital) or false (acquired); the latter is classified as either primary or secondary. The wall of the true diverticulum contains all of the layers of the normal intestinal wall. The false diverticulum shows the absence of one or more muscular layers. Diverticula of the left half of the colon are not unusual; they are found in about 5 per cent of all persons over forty years of age.<sup>3,4</sup> However, diverticula con-

fined to the cecum alone are unusual. Greensfelder and Hiller<sup>5</sup> made some interesting observations on the etiology of false secondary or traumatic cecal solitary diverticula and reported four cases. They concluded this type of diverticulum resulted from (1) eversion of the cecal wall between two constricting adhesive bands, (2) traction of a narrow adhesion on the cecal wall, (3) eversion at the stump site of the appendix due to migration of silk purse-string sutures into the cecum and (4) eversion at the appendiceal stump site the result of weakness following rupture of a stump abscess into the lumen of the bowel.

The greatest number of solitary cecal diverticula was found on the lateral and anterior cecal wall. A few were located on the medial and posterior wall. Including our cases, twelve were reported as true diverticula and eleven false; in twenty-four sufficient data were not available to determine the type; in one of our cases the type could not be determined. A fecalith was found in the diverticulum in twenty-one (43.75 per cent) of the reported cases; in the others it was not found or not mentioned.

The preoperative diagnosis in over three-fourths (77.08 per cent) or thirty-seven of the forty-eight cases, including our own, was appendicitis. Five of the thirty-seven were thought to be appendiceal abscess and one stump appendicitis. In three instances cancer was the preoperative diagnosis; in the remaining group no definite statement was made except in one instance, an abscess of undetermined origin.

The type of operation performed including our three cases was diverticulectomy twenty; resection of the cecum and/or ascending colon sixteen; inversion of the

diverticulum four; cut adhesions one; closure of perforation two; anastomosis or drainage three; and extraperitonealization of abscess one. In this group of forty-eight cases there were only two deaths; one was in the group of colon resections, and one was due to bronchopneumonia following drainage of a pericecal abscess.

The disease occurs in the male and female with about equal frequency. About one-half of the reported cases were in individuals under forty years of age; about one-half were over forty years. Our three cases fell in the third decade.

Symptomatically, acute cecal diverticulitis is acute appendicitis. Twenty-two patients (45.83 per cent) had previous attacks of lower abdominal pain. About one-third of the patients will have epigastric or generalized abdominal pain at the onset with subsequent localization in the right lower abdomen. However, the right lower abdominal pain was usually crampy in character. In the table of comparisons of the symptoms of acute appendicitis to those of acute diverticulitis<sup>1</sup> nausea and vomiting occur about half as frequently in diverticulitis as in appendicitis. In cecal diverticulitis practically all had tenderness in the right lower quadrant on examination, and about 80 per cent had muscle spasm. In a rather large percentage a mass was detected. The average temperature was about 99.6°F. with a pulse average between 80 and 90. The white blood count varied from normal to over 22,000, the average being about 12,700. The average white blood count in the series of appendicitis reported by Reid, Poer, Merrel<sup>6</sup> was 17,200.

As previously pointed out, practically all the patients in the cases reported were operated upon with a diagnosis of acute appendicitis. But with the abdomen opened, the pathological findings in many instances were much more extensive than simple local inflammatory involvement of a diverticulum, and difficulty in diagnosis arose. The lesion had developed into a large firm indurated mass that involved the

cecum and had an appearance resembling carcinoma of the cecum. When one considers that cancer is next in frequency to appendicitis as a lesion of the cecum, the reasons for the mistakes made in the diagnosis and radical resections performed are understandable.

With a large mass of the cecum, palpation of the mass through the opposite cecal wall may reveal the mouth of the diverticulum. This was of value in one of our cases in establishing the diagnosis of cecal diverticulitis at the operating table. Baker and Carlile point out it will aid in the differential diagnosis if the three types of malignant tumors of the bowel are kept in mind, i.e. the type that grows by cauliflower-like projection into the bowel lumen and is very slow to metastasize, the type that grows by true extension through or along the various coats of the bowel and is more likely to show glandular metastasis, while the third type rapidly ulcerates through the bowel and shows many glandular metastases.

In tuberculosis of the cecum, as a rule the ileum is also involved, and sometimes small tubercles can be seen on the serosa. The peritoneum is usually thickened and adhesions are present. The lymph glands are large and caseous.

Other more rare lesions as actinomycosis and so-called simple ulcer (non-specific ulcer) of the cecum may have to be considered in the differential diagnosis. The former condition may start in the appendix or cecum. Early, there is thickening of the cecal wall and little abscesses and sinuses form. If the sulfur granules can be found, the diagnosis is established. Simple ulcer usually occurs on the medial wall of the cecum as pointed out by Barrow,<sup>7</sup> Wilkie,<sup>8</sup> and Cameron.<sup>9</sup> This lesion has been reported slightly more frequently than solitary diverticulitis. This lesion, like diverticulitis, may present a picture suggesting malignancy with the result that right colectomy has been done. Those who have written on the subject believe that surgery for this lesion should be minimal.



Treatment of acute diverticulitis has varied from no treatment, drainage of pericecal abscess, diverticulectomy, inversion of the diverticulum, to resection of the cecum and right colon. The mortality has been low in this series of forty-eight cases. Only two deaths have occurred; one followed right colectomy, and one was from bronchopneumonia and cardiac failure following drainage of a pericecal abscess. Because of the tendency of diverticulitis to recover spontaneously, no extensive surgery is ordinarily necessary.

Burgess<sup>10</sup> points out that the course of diverticulitis is to subside without perforation or other complication. Of the five cases that came under his observation, two had appendectomy at operation, but no surgery to the diverticulum. In one instance (previous appendectomy) he made a clinical diagnosis of cecal diverticulitis and did not operate; the diagnosis was confirmed by x-ray on the second hospital day. The patient recovered. Schnug reports a case of an acute diverticulitis on the lateral cecal wall which was not disturbed at operation, but the appendix was removed, and the patient recovered. Another patient in his series had a pericecal abscess which was drained. The patient died on the fourteenth postoperative day of bilateral pneumonia and cardiac failure. At postmortem the inflammatory process in the diverticulum and the surrounding cecum had subsided completely.

Schnug, after his analytical review of this subject, stressed the importance of doing only minimal definitive surgery and even this, in most cases, was probably not advisable. In our experience with three cases we did diverticulectomy twice and inversion of the diverticulum once.

#### CASE REPORTS

**CASE 1.** A white male, age twenty-six, was admitted to the hospital February 17, 1943, complaining of a constant right lower abdominal pain with increasing severity of twenty-four hours' duration. About forty-eight hours before admission, he was seized with a mid-abdominal, crampy, sharp pain which was

followed by a brief period of nausea but no vomiting.

Examination revealed a slender, rather poorly nourished individual complaining of right lower quadrant pain. Temperature was 99.8°E. pulse rate 86. The heart and lungs were normal. The abdomen was flat; there was acute tenderness, moderate muscle spasm in the right lower quadrant with both local and referred rebound tenderness in the right lower quadrant. Brittain's sign was positive. The abdomen had a slightly doughy feeling. The examination of the blood showed red blood cells 4.2 million, hemoglobin 80 per cent, white blood cells 14,200 with 85 per cent polymorphonuclears. The urine was negative. The pre-operative diagnosis was acute suppurative appendicitis.

The abdomen was opened through a McBurney incision. The cecum was markedly injected, and a mass the size of a large walnut was present on the anterior cecal wall approximately three inches distal to the appendix on the tenia. The omentum was plastered to this firm mass. After the omentum was freed from the cecum, considerable fibrinous exudate was present. The mass was a diverticulum of the cecum and contained a fecalith which measured by palpation roughly 1.5 by 1 cm. The fecalith was manipulated into the lumen of the bowel. The diverticulum was inverted by a purse-string suture. The appendix showed slight serosal injection; it was removed.

The postoperative course was entirely uneventful. On the twenty-third postoperative day a barium enema was done which was negative for diverticula.

**CASE 11.** A white male, age twenty-seven, was admitted to the hospital on June 20, 1943, complaining of abdominal pain. For about two weeks the patient had been having mild, right lower, crampy abdominal pain, associated with slight nausea and diarrhea. He had six or seven loose, soft stools daily for four or five days. After this period, he was more or less constipated. For the past two days the pain in the right lower quadrant had been constant but not particularly severe. There was some loss of appetite. In the past two years he had had four similar attacks that lasted about four days each.

Examination revealed a well nourished and developed individual who appeared to be in no acute pain. Temperature was 97.4°F. and pulse

56 on admission. The heart and lungs were normal. The abdomen was flush with the thoracic cage and there was slight tenderness in the right lower quadrant on moderately deep palpation. Rectal examination revealed nothing abnormal. A blood count showed red blood cells 4.95 million, hemoglobin 95 per cent, white blood cells 10,550 with 76 per cent polymorphonuclears. A urinalysis was normal. An emergency stool examination revealed 4+ occult blood, and no parasites or ova were found. The impression was that we were probably dealing with a low grade appendicitis. He was kept under observation. The following morning, June 21, 1943, the pain and tenderness in the right lower quadrant were definitely increased over the preceding day. Proctoscopy was negative. Another blood count showed 10,350 white blood cells with 62 per cent polymorphonuclears. The temperature was 98.8°F., and the pulse rate 88. Because of the increased pain and tenderness, a diagnosis of acute appendicitis was made.

The abdomen was opened through a McBurney incision. A firm mass covered by an indurated greater omentum was found on the anterior wall of the cecum opposite the ileocecal valve. The anterior cecal wall was rather friable, and there was rather marked vascularity. The omentum close to the mass was divided, the mass was then freed to a pedicle which measured about 1.5 cm. in diameter. Diverticulectomy was done and the defect was closed with two rows of continuous catgut sutures. The appendix was retrocecal, showed no gross abnormality, and was removed.

Microscopically, the diverticulum showed hyperemia of the serosa with an inflammatory reaction in the wall. This was associated with hemorrhage and edema. The inflammatory reaction was acute and composed chiefly of polymorphonuclear leukocytes diffusely infiltrating the wall including the mucosa. The muscularis mucosa was present. The outer layer contained muscle fibers which were present both in longitudinal and cross sections. The pathological diagnosis was diverticulitis of the cecum (true or congenital diverticulum) and fibrous appendix.

The postoperative course was uneventful except for mild paralytic ileus which was controlled easily with Wangensteen suction and prostigmine. Postoperative stool examinations were negative. A barium enema was done about

twenty-three days after operation and was entirely negative.

CASE III. A white male, age nineteen, was admitted to the hospital August 6, 1943, complaining of right lower abdominal pain. About twenty-four hours before admission, the patient was seized with generalized abdominal cramps associated with slight nausea. After about six hours the cramps disappeared and left him with residual soreness in the right lower abdomen. His blood count five hours before admission showed 13,000 white blood cells with 80 per cent polymorphonuclears. He was sent to the hospital by his family physician with a diagnosis of acute appendicitis. About four years previously, the patient had a similar attack that lasted one day, but it was not as severe as the present one. His present abdominal complaint was the first in four years.

Examination revealed a well developed and nourished individual complaining of right lower abdominal pain which was aggravated on cough or change of position. His temperature was 99°F. and pulse 100. The heart and lungs were normal. The abdomen was slightly scaphoid, and there was definite localized acute tenderness with slight rigidity in the right lower abdomen over McBurney's point. There was slight rebound tenderness, locally, and referred rebound tenderness from the left quadrant to the right lower quadrant. A blood count showed white blood cells, 11,850 with 78 per cent polymorphonuclears. The urine was negative. The preoperative diagnosis was acute appendicitis.

The abdomen was opened through a McBurney incision. The cecum was lying rather high but could be delivered into the wound. The entire cecum was moderately inflamed. On the lateral wall of the cecum just opposite the tenia there was an indurated, endematous, and markedly inflamed structure which measured about 3.5 cm. in diameter. Palpation of the mass through the medial wall revealed a depression which felt like an ulcer or an opening into a diverticulum. The mass was dissected free down to a rather narrow neck that communicated with the bowel; this entire mass was resected. The defect in the wall was closed with two rows of continuous Lembert type sutures. There was no enlargement of the mesenteric glands. The appendix was retrocecal, coiled on itself, and bound to the posterior cecal wall by congenital bands; it was inflamed and gave

the appearance of a periappendicitis; it was removed. Five gm. of sulfanilamide crystals were sprinkled into the operative area, and the wound was closed.

Microscopic sections of the diverticulum showed a small abscess formation. In one area there was a mucosal surface with glands lined by columnar cells which contained globules. The muscularis mucosa was fragmented. There was an occasional small lymph follicle in the mucosal zone. The outer layer contained muscle fibers which were present in longitudinal and cross sections. There was a diffuse inflammatory infiltration in the entire wall with a small area of necrosis which almost completely replaced the wall. There was purulent exudate on the serosal layer. A section of the appendix showed perivascular lymphocytic infiltration with numerous leukocytes in the serosal layer with edema in this zone. There were scattered lymphocytes and leukocytes in the muscular coat. The lymph follicles and mucosa were intact. The diagnosis was acute diverticulitis of the cecum (congenital type diverticulum) and peri-appendicitis.

The postoperative course was uneventful except that the patient ran a low grade fever for the first ten postoperative days. A barium enema done twenty days postoperatively was negative.

#### COMMENT

Twenty-two patients out of forty-eight reported cases of solitary cecal diverticulitis had previous attacks of lower abdominal pain. Two of our three patients gave definite histories of previous attacks. Another striking feature was the frequency (43.75 per cent) in which a fecalith was present in the diverticulum. Fecaliths, no doubt, (mechanically as in appendicitis) play an important rôle in the etiology of acute cecal diverticulitis. When diverticulitis does occur, it does not always remain a simple localized cecal diverticulitis as evidenced by the extensiveness of the inflammatory process in some of the reported cases. Diverticulectomy has been performed twenty times and inversion four times with no important morbidity and no mortality. In order to prevent future attacks, the solitary diverticulum should be removed or inverted when such treatment is feasible.

If the inflammatory reaction is too extensive for simple excision or inversion, reliance on spontaneous recovery is preferred to the more radical operative procedures.

#### SUMMARY

1. Solitary diverticulitis of the cecum is an uncommon lesion and in the majority of the reported cases has been preoperatively diagnosed as appendicitis, and at the operating table has been frequently diagnosed as carcinoma of the cecum.
2. A total of forty-eight cases has thus far been reported in the American and British literature.
3. Solitary diverticulitis occurs with about equal frequency in the male and female and occurs in most age groups.
4. Minimal surgery should be done because of the tendency of diverticulitis to subside spontaneously; however, diverticulectomy or inversion of solitary diverticulum should be done if possible.
5. Three cases of solitary diverticulitis of the cecum are reported, two of which were true or congenital diverticula, one could not be determined. Two were treated by diverticulectomy and one by inversion.

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## POSTOPERATIVE PHYSIOLOGICAL CHANGES IN REGIONAL ILEITIS\*

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THE symptomatology, pathology, and treatment of regional ileitis have been described in the classic papers of Crohn, Ginsberg and Oppenheimer<sup>1</sup> and subsequent writers on the subject.<sup>2-5</sup> The purpose of the present report is to discuss the physiological variations noted in two cases recently observed simultaneously in the wards of this hospital. A review of the available literature has failed to reveal mention of these changes which one would assume must be fairly common in similar patients treated by two-stage operations and which pose interesting problems in postoperative management.

### CASE REPORTS

CASE 1. The patient age twenty-one, was admitted June 3, 1944, complaining of tenderness of his entire abdomen, particularly around the umbilicus and in the right lower quadrant, and cramp-like pains which occurred every fifteen to twenty minutes. These symptoms were of eleven months' duration and were accompanied by weakness, easy fatigability, loss of twenty-five pounds in weight, anorexia, and polydipsia. He stated that he had no desire to defecate when the cramps occurred but had five or six loose stools a day. There was no nausea or vomiting and no blood has been noted in the stools.

In July, 1943, while serving as an aviation cadet in the Army, he began to notice persistent pain in the right lower quadrant and a diagnosis of subacute appendicitis was made. On July 16, 1943, he was operated upon in an Army Hospital but the appendix was not removed because "the ileum was found to be red and injected with numerous glands the size of peas." After five months of supportive treatment in Army Hospitals, he was invalidated from the service. Following his discharge in

December, 1943, he took a job as a clothing salesman but was forced to quit in April, 1943, because of the recurrent attacks of abdominal distress.

Previous medical and the family histories were irrelevant.

Physical examination revealed a well developed, poorly nourished white adult who appeared chronically ill. During the course of the examination he had recurring spasms of cramps every ten to fifteen minutes which caused him to grit his teeth. Temperature was 100°F., pulse 104, respirations 20, blood pressure 106/60. The abdomen presented a well healed transverse operative cicatrix in the right lower quadrant. Even light palpation of this area resulted in severe voluntary spasm of the muscles of the abdominal wall; true rigidity was also present. The intestines were moderately dilated and an audible gurgling and rumbling sound was noted after each spasm of pain. No definite mass could be made out. On rectal examination tenderness was elicited on the right but no mass was felt. The physical examination was otherwise essentially negative.

Laboratory data: Erythrocytes 4,240,000; hemoglobin 11 G.; leucocytes 8,100 with a differential of 1 myelocyte, 9 band and 58 segmented forms, 29 lymphocytes, and 1 each of eosinophiles, basophiles and monocytes. Urinalysis was normal; the sedimentation rate was 28.

A gastrointestinal x-ray series after a barium meal revealed considerable delay in the small bowel "either in the terminal jejunum or ileum; at the end of 6 hours a small amount of barium is seen in the colon but the ileum appears to be remarkably distended, especially on the left side." A barium enema was not remarkable.

During the week following admission the temperature varied from 99 to 101°F. with a pulse rate of 80 to 110. A second blood count

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revealed an increasing anemia, and two transfusions were given.

On June 21, 1944, an exploratory laparotomy

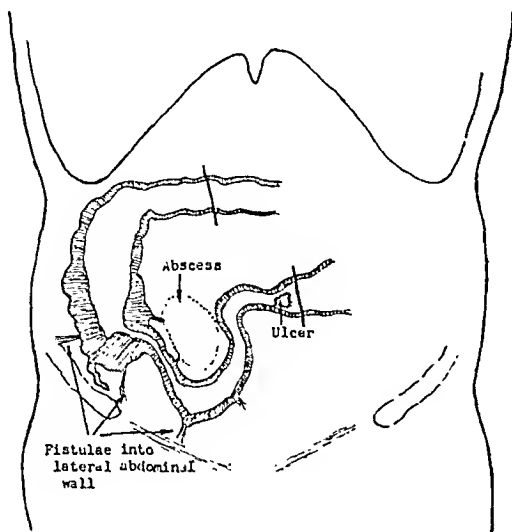


FIG. 1. Semi-diagrammatic drawing of condition found at operation and amount of bowel removed in Case 1.

was done under spinal anesthesia. The abdomen was opened through a right pararectus incision. A large mass which was overlaid with adherent omentum was encountered in the right iliac fossa with extension into the pelvis. After freeing the omentum the mass was dissected free from the lateral abdominal wall and delivered into the incision. It was found to consist of a large loop of ileum and the cecum which surrounded a mass the size of a lemon in the mesentery. Several sinus tracts between the mass and the lateral abdominal wall were encountered. The ileum was traced cephalad until healthy tissue was found and was divided between clamps. The ascending colon and hepatic flexure were mobilized and the transverse colon was divided between clamps just distal to the flexure. A double-barreled ileocolostomy was then formed in accordance with the Lahey technic<sup>6</sup> and brought out through the upper end of the incision. After peritoneal toilet, including the introduction of sulfanilamide crystals and a Penrose drain into the pelvis, the abdomen was closed in layers about the ileocolostomy. Figure 1 is a semi-diagrammatic representation of the condition found at operation and the amount of bowel removed.

A clamp was applied to the spur on the seventh postoperative day and, after two subsequent applications, the spur was cut down sufficiently to provide a good stoma between

the small and large bowel. The final closure of the colostomy was postponed until September 4, 1944, because of the development of considerable irritation of the abdominal wall caused by the intestinal discharges. Following several days of preoperative preparation with succinylthiazole, the ileocolostomy was freed down to the peritonum and closed with two layers of chromic catgut and a layer of sero-serous mattress sutures of fine stainless steel wire. During the closure the peritoneum was inadvertently opened. Through-and-through wire sutures were passed through the layers of the abdominal wall to the peritoneum but were not tied. The incision was packed with vaseline gauze after frosting with sulfanilamide crystals and the sutures tied several days later. Healing by second intention occurred promptly.

At the present time the patient is asymptomatic and has gained forty pounds in weight. With the exception of two small sinuses which extend only through the skin at the lower end of the incision and which are healing, the abdominal incisions are firm.

CASE II. A seaman first class, age twenty-three, was admitted March 27, 1944, because of a fistula-in-ano of four months' duration which apparently followed an ischiorectal abscess. Previous medical history was negative except for an appendectomy in 1924 at the age of three. Physical examination revealed a well nourished and well developed white adult who did not appear acutely ill. His temperature was 99.6°F., pulse 96, respirations 16, blood pressure 110/44. The examination was otherwise essentially negative except for a draining fistula which opened externally on the right buttock and internally into the anal canal. On March 31, 1944, the fistulous tract was laid open. Convalescence was uneventful, although the tract healed slowly, until May 28th when he began to complain of epigastric pain which was relieved by food. Sometime around this date he complained for the first time of pain in his abdomen, but when it was found that his appendix had been removed, not much attention was paid to it. He continued to complain of abdominal discomfort and on June 6th a series of gastrointestinal x-rays following the ingestion of a barium meal revealed a deformity of the duodenal bulb that appeared to be caused by extrinsic pressure. On the six-hour film "there is a rather unusual appearance of the lower pole of the cecum" and a barium

enema was advised. X-ray of the chest was negative.

On June 12th, a mass which apparently

was responsible for the slow emptying of the terminal ileum. . . The tumor moved with the cecum and we believe it is part of the cecum. The

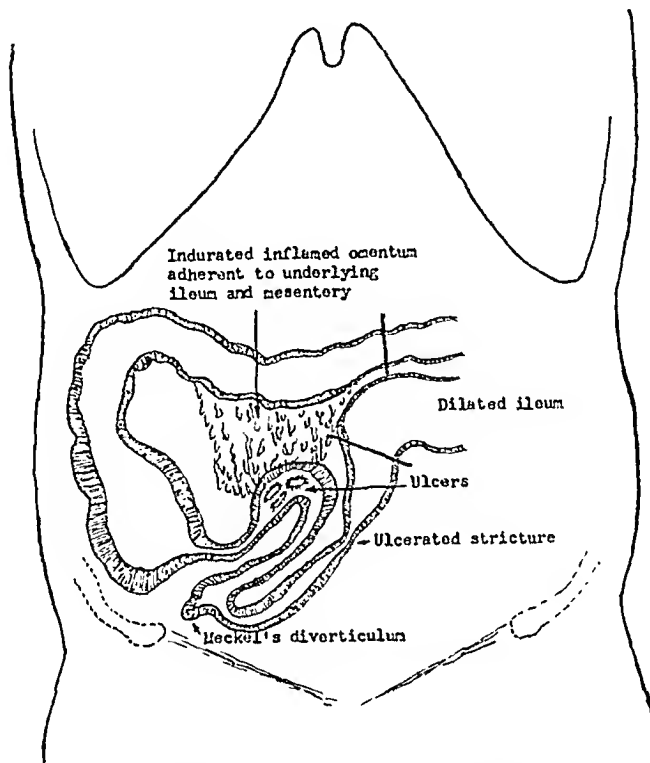


FIG. 2. Semi-diagrammatic drawing of condition found at operation and amount of bowel removed in Case 11.

involved the cecum was made out on physical examination for the first time. Rectal examination confirmed the presence of a large indurated mass in the right iliac fossa. A blood count revealed 3,720,000 erythrocytes, hemoglobin 10.5 Gm., leucocytes 9,400 with a differential count of 6 band and 71 segmented forms, 22 lymphocytes and 1 basophile.

A barium enema on June 13th failed to fill out the cecum at any time during the examination. The films showed "a filling defect in that area and a definite tumor can be felt." The gastrointestinal series was repeated on June 17th and the presence of a deformed duodenal cap confirmed. In addition, "there is some distention of the jejunum but we could not demonstrate any narrowing of any part of the small bowel. The barium entered the cecum at the end of 2½ hours but there still remained some barium in the ileum and no abnormal intestine was seen in the region of the mass in the right lower quadrant. The mass which could be palpated appeared to involve the lower part of the cecum and terminal ileum and was re-

incompletely filled terminal ileum and cecum did not have the characteristic picture of ileitis. It does not appear to have the appearance of tuberculosis or of a malignant lesion. We believe the tumor is a non-malignant inflammatory mass."

During this period of observation, the temperature chart showed an occasional rise to 100°F. with a pulse rate of around 80 per minute. A blood count on June 24th was reported: erythrocytes 4,180,000; hemoglobin 84 per cent; white blood cells 14,250. Sulfadiazine was given with some apparent improvement and the mass in the right lower quadrant appeared to decrease in size. During the last five days in June, however, the temperature curve began to show a low-grade septic course which increased to 101°F. on July 6th.

A skin test with 0.1 cc. of a 1/20 dilution of O.T. on July 3rd gave a negative reaction. On July 7th, it was noticed that the mass was again increasing in size and that the patient had lost seven pounds during the last two weeks. The red cell count dropped to 3,570,000

and a transfusion was given. Other laboratory data at this time were recorded as follows: stool negative for ova and parasites; sedimentation rate 26, gastric contents negative for acid-fast bacilli; non-protein nitrogen 25.3 mg. per cent; blood chlorides 465, serum protein 7.01.

On July 11th an exploratory laparotomy was done under metycaïne spinal anesthesia. On opening the abdomen a large inflammatory mass involving the terminal ileum, cecum, ascending colon, and part of the transverse colon was found. This mass was densely adherent to the greatly thickened parietal peritoneum. The mesentery of the terminal ileum and the mesocolon were thickened and edematous. A large amount of free peritoneal fluid was present. The terminal ileum, cecum, ascending colon and half of the transverse colon were mobilized and resected. A Lahey-Mikulicz type of ileocolostomy<sup>6</sup> was done and the abdomen closed in layers without drainage. Figure 2 is a semi-diagrammatic representation of the findings at the operation and the amount of tissue removed.

The postoperative course is discussed below. Following a suggestion made by Fauley and his associates,<sup>7</sup> penicillin was started intramuscularly in doses of 20,000 units every three hours and plasma and blood transfusions were given. For the first two days postoperatively the highest temperature was 99°F.; on the third day some abdominal distention became apparent and the temperature rose to 100°F. A Levine tube was introduced. The temperature remained elevated for three more days with a rise to 103°F. on the morning of the sixth postoperative day, and then fell to normal where it remained during the remainder of the convalescent period.

On the sixth postoperative day the "spigot" of the ileocolostomy was removed with the cautery and a clamp applied to the spur. Two subsequent applications of the clamp were made until an adequate stoma was obtained. The ileocolostomy was closed on September 11, 1944 after several days of succinylthiazole medication and healed by first intention.

At the present time the patient has no complaints except two to three loose stools a day. He has gained thirty pounds since operation but is not yet back to his normal weight.

#### COMMENT

Histological examination of the tissues removed at operation in these two cases

revealed the picture usually encountered in regional ileocolitis. Areas of mucosal destruction with necrosis and polymorphonuclear infiltration were associated with areas in which fibrosis with diffuse invasion of small round cells, plasma cells, large numbers of eosinophiles, and polymorphonuclear cells were prominent. Occasional foreign body giant cells were present but there was no evidence of malignancy or tuberculosis.

After combating the initial surgical shock resulting from the extensive resections carried out in these two cases, the most serious problem encountered in the postoperative period was that of extracellular dehydration. While such problems are to be expected in patients with ileostomies and have been recognized in other discussions in the literature, the difficulty in controlling the water and electrolyte balance in the two cases described seemed much greater than would ordinarily be expected in procedures of this type.

Tables I and II record the variations in the hematocrit, blood chlorides, and serum protein that occurred in the postoperative course of these patients. The quantities listed under "Intake" include the amounts of fluids taken by mouth and administered parenterally and does not include an estimation of the water content of the foods ingested or of water of oxidation. Similarly, the "Output" comprises the volume of urine excreted and the vomitus as well as the ileostomy drainage up to the seventh postoperative day when the projecting limb of ileum was removed and does not include the drainage from the ileostomy after that date nor the water and electrolytes lost from excessive sweating and attacks of diarrhea. All laboratory studies were made in the morning hours so that the fluids administered each day are reflected in the succeeding days' tests.

It will be noted that when an increase in the hematocrit is shown, the serum protein also increases but in most instances the blood chlorides decrease. In other words, hemoconcentration in these cases was

accompanied by a decrease in blood spaces, of which the fluid portion of the chlorides rather than an increase, as would body is a part, were called upon to furnish ordinarily be expected. It is our opinion the difference. In order to maintain the

TABLE I

Days P.O.	Hemato- crit	Blood Chlo- ride	Serum Prot.	RBC	In- take	Out- put*	I.V. Glu- cose Saline	Plasma Cc.	Whole Blood Cc.	
0	....	...	...	...	5250	500	4000	250	1000	Moderate surgical shock
1	38.0	522	6.12	...	6000	800	6000	...	500	
2	....	...	...	3.8	4800	650	4000	...	500	
3	....	...	...	4.2	3800	1600	2000	...	500	Profuse ileostomy drainage
4	49	454	7.14	...	5310	1525	3000	...	500	
5	44	486	6.64	...	4110	1955	3000	...	500	
6	....	...	...	...	1960	1760	....	....	...	Drainage tube removed from ileum
7	....	...	...	...	2580	2760	....	....	...	Vomiting
8	....	...	...	...	3320	1020	....	....	...	High protein diet
9	51	412	7.70	4.0	5400	425	....	....	500	
10	46	484	6.74	...	2460	1000	...	...	...	
11	....	...	...	...	2340	1900	...	...	...	
12	....	...	...	...	1630	460	...	...	...	
13	48	446	6.86	...	1430	825	....	....	...	Profuse ileostomy drainage
14	....	...	...	...	2280	1430	...	...	...	
15	47	461	6.92	...	2225	1220	...	...	...	
16	....	...	...	...	2430	1175	...	...	...	
17	....	...	...	4.7	2475	1390	...	...	...	
18	50	412	7.60	...	2790	1795	2000	250	...	
19	47	432	7.42	...	2400	1660	...	...	...	
20	....	...	...	...	2200	1595	...	...	...	
21	52	408	7.62	...	2540	1200	...	...	...	
22	43	429	7.32	...	2360	525	....	500	...	
25	46	422	7.40	4.1	2640	1000	...	...	...	
27	49	411	7.36	...	2200	585	....	....	...	Vomiting and diarrhea
29	54	396	7.67	...	6000	2510	3000	1500	...	Shock BP 50/30
30	39	453	7.54	3.5	5100	2050	2000	....	...	Cond. good BP 96/70
31	....	...	...	...	5150	2825	2000	...	500	BP 118/76
32	44	445	7.00	4.2	3650	1575	....	...	...	BP 116/76
34	53	430	7.20	...	4990	2000	1000	250	...	Vomiting, diarrhea, marked weak- ness
35	49	447	7.09	...	4520	2025	....	....	...	Better, BP 100/74
36	48	404	6.97	3.8	4500	1640	....	500	...	Weak BP 86/68
37	48	478	7.50	...	4370	2025	....	....	500	Better BP 104/76
39	52	396	7.58	...	3460	1200	....	....	...	Vomiting, weak
40	54	404	7.93	4.3	6540	2750	2000	500	...	BP 84/66
41	47	429	7.54	...	4040	1350	....	....	500	Improved BP 96/70
45	53	437	7.69	...	4280	1425	....	500	...	Vomiting BP 92/70
46	48	446	7.79	...	4060	2500	....	....	500	Better, drainage less, BP 94/72
49	47	453	7.5	4.1	3850	1550	....	....	...	Out of bed, BP 118/80
60	45	480	7.21	4.3	....	....	....	....	...	Walking; condition good—drain- age from ileostomy slight; having regular bowel movements.

\* Drainage from ileostomy could not be recorded after removal of drainage tube on the seventh postoperative day.

that the hemoconcentration here is caused by the extensive loss of the sodium and chloride ions from the body with a resulting extracellular dehydration. As the loss of electrolytes through the intestinal drainage exceeded the supply, the extracellular

proper concentration of the remaining electrolytes, the fluid volume of the blood is reduced and hemoconcentration occurs.

When the volume of the circulating blood reaches the critical level there may be a sudden circulatory collapse and the



typical picture of shock is presented. It is interesting to note that this is precisely what happened in Case 1 on the twenty-several days thereafter the water and electrolyte balance were very difficult to maintain and it was frequently necessary

TABLE II

Days P.O.	Hemato- crit	Blood Chlo- ride	Serum Prot.	RBC	In- take	Out- put*	I.V. Glu- cose and Saline	Blood Plasma Cc.	Whole Blood Cc.	
0	..	465	7.01	4.2	5100	550	3000	750	1350	Moderate surgical shock
1	41	412	6.21	4.4	5500	1735	5000	...	500	
2	41	519	6.80	...	3150	1500	2000	...	...	
3	39	412	6.67	...	4850	5300	3000	...	500	Vomited
4	39	445	6.30	...	5610	5260	2000	...	....	Vomited
5	39	511	5.05	...	5760	4580	2000	...	...	
6	..	...	...	4.3	5640	8675	2000	...	500	Profuse drainage from ileostomy
7	43	482	6.40	...	5630	3225	2000	...	...	
8	45	462	7.59	...	6460	3470	2000	...	....	Clamp applied to septum
9	..	...	...	...	6050	3325	....	...	....	Vomited
10	45	404	6.71	4.7	6290	3700	...	...	....	
11	42	402	6.80	4.1	3620	2600	2000	...	....	Vomited 2000 cc.
12	43	462	7.15	4.2	3000	1645	...	...	....	
13	41	445	6.98	...	5140	2280	1000	...	500	
14	46	426	6.90	...	4020	1050	....	...	....	Ileostomy drainage profuse
15	51	404	7.30	...	3240	2035	...	...	...	
16	51	385	6.90	3.9	3190	1610	2000	500	...	
17	45	495	6.70	...	2640	1560	....	...	500	
18	47	429	6.90	4.3	2775	925	...	...	...	
19	..	...	...	...	3200	1885	...	...	...	
20	46	429	7.01	...	4680	2580	2000	...	....	Bowels moved through rectum
21	47	453	7.78	...	4700	2620	...	...	....	
22	48	429	6.50	...	5050	2700	2000	...	....	Bowels moving B.I.D.
23	46	432	6.24	4.6	4500	3015	1000	...	....	Ileostomy drainage less
24	47	420	7.05	...	3800	2905	...	...	....	
25	45	445	7.79	...	3800	1700	...	...	....	
26	..	...	...	...	3700	1480	...	...	....	
27	46	429	6.90	...	3510	1525	....	...	....	Bowel movements regular
28	47	440	7.20	...	3550	1460	...	...	....	
29	46	445	6.16	4.9	3400	1425	....	...	....	Ileostomy drainage subsiding
30	44	440	7.19	...	3700	1400	....	...	....	Up and about
34	44	445	7.30	...	3900	1350	...	...	....	
37	39	478	7.70	...	3400	2600	...	...	....	
42	40	480	7.60	4.7	2800	1200	...	...	....	

\* Ileostomy drainage not included in output after the seventh postoperative day because external portion of ileum had sloughed and drainage was then absorbed by dressings.

ninth postoperative day. For several days previous to this episode he seemed to be getting along exceedingly well, so well in fact that some of the daily laboratory checks on him were omitted. Then, suddenly, and without warning, serious surgical shock was precipitated. The picture was dramatically controlled by the rapid infusion of large quantities of plasma and normal saline given simultaneously but for

to administer one or two units of plasma in addition to the saline to re-establish quickly the precarious equilibrium.

In neither of these cases were we able to maintain the blood chloride levels at the accepted normal values during most of the postoperative period. Attempts were made on several occasions to push sodium chloride by mouth as well as by venoclysis, but in each instance this resulted in

diarrhea which was usually followed by vomiting with a further loss of electrolytes. The balance was extremely sensitive throughout and could be controlled only by constant checking of the laboratory findings as well as the clinical condition of the patients.

Throughout the postoperative course of these two patients, the serum protein was maintained within fairly normal limits by repeated blood transfusions and plasma when indicated and by a high protein diet. Most of the variations noted in the tables are attributed to variations in the hemoconcentration.

#### SUMMARY

Two cases of regional ileitis in which the patients were treated by extensive resections of small bowel and colon are described. In both cases the postoperative variations in the hematocrit, blood chlorides and serum protein were extremely difficult to control. Relaxation of the vigilance required may result in the ap-

pearance of typical surgical shock as late as the twenty-ninth postoperative day or, indeed, until the ileocolostomy is closed. A constant check of the water and electrolyte balance by laboratory methods is necessary to anticipate and control such variations by prompt administration of whole blood or plasma, before critical levels are attained.

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# COMPLETE AVULSION OF THE SCALP

## REVIEW OF THE LITERATURE AND CASE REPORT

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CASE reports of avulsion of the scalp are not uncommon in medical literature, yet, these reports are usually

Boerhaave,<sup>3</sup> Vance and Robertson<sup>4</sup> in the eighteenth and nineteenth centuries advocated similar procedures. Downs reported

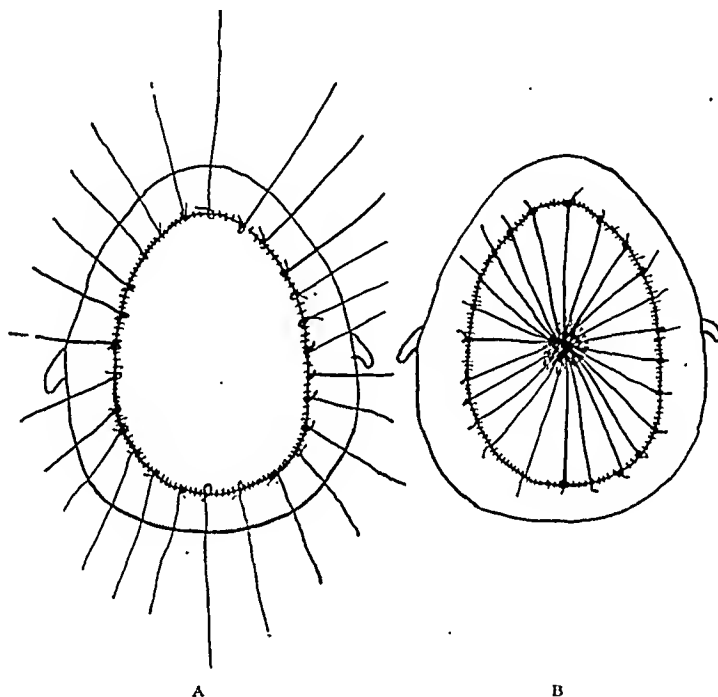


FIG. 1. A, continuous running suture of catgut and interrupted heavy black silk sutures. B, black silk sutures tied over several thicknesses of gauze to form a stable pressure dressing.

of interest. Luther Strayer,<sup>1</sup> in searching through the literature, found that in 1696 Augustin Beloste,<sup>2</sup> a great French Surgeon, advocated skull trephining to produce granulations after scalp avulsion. Beloste stated that, "In order to prevent the bone from becoming altered and carious . . . it is necessary at the first dressing or as soon as possible to pierce the bone in several places with the pyramid or perforator of the trephine; in this manner one gives passage to a marrow juice which, oozing out, covers the bone in a short time without loss of the least part of its substance."

the earliest case of industrial scalping in 1838. Netolitzki was the first to report the use of grafts in the treatment of avulsed scalps. Davis,<sup>5</sup> in 1911, summarized 132 cases of avulsion of the scalp. He found that in most instances the pericranium was uninjured and left intact, in fewer cases partial pericranial destruction occurred, whereas in only a few was the pericranium totally destroyed. Coleman<sup>6</sup> reported two cases in which the scalp with all of the pericondrium was destroyed by burns.

Scalping of their victims was practiced by early American Indians. Accidental

scalp avulsion has occurred from burns, animal claws and industrial mishaps. With the advent of women into mechanized industry, the possibility of industrial scalp- ing has greatly increased.

#### TREATMENT

The immediate treatment of avulsed scalps is the control of hemorrhage which may be severe. Pressure is the most satisfactory method until the patient can be brought to an equipped emergency operating room where the bleeders may be caught and ligated. Shock, anti-gas gangrene, and anti-tetanic therapy are essential. Skull radiographs and a thorough neurological examination should be performed to detect any cerebral injury. If the scalp is not completely avulsed and a pedicle remains, the flap should be shaved, thoroughly cleaned and disinfected. The margins should be débrided if ragged, and the flap sewn back to the head. A take usually ensues even though only a small pedicle is present.

Scalps which have been completely torn away from the head present the problem of attaining a satisfactory blood supply. The separation usually occurs in the sub-aponeurotic layer leaving the pericranium intact. After proper surgical preparation, the defect should be carefully examined to determine the state of the pericranium. The treatment of such cases falls into two categories: those in which the pericranium is intact, and those in which it is destroyed.

1. *Pericranium Intact.* If the scalp is severely macerated or impregnated with dirt or grease particles making it impossible to clean, it should not be replaced as the danger of infection with resulting meningitis is too great. However, should the scalp be obtainable in fairly good condition, the hair could be shaved off, and the scalp thoroughly cleaned and disinfected. It could then be washed in normal saline and reapplied. Davis<sup>5</sup> reported twenty-one attempts at such treatment with complete failure in all cases save one. Malherbe claimed the greater

part of an avulsed scalp healed after replacement but his result is doubted. Lejars<sup>7</sup> commenting on Malherbe's case



FIG. 2. Photograph of the patient's avulsed hair.

stated, "That after careful disinfecting by shaving and brushing with soap and sublimate solution the scalp was readjusted and sutured. The scalp died but turned into a parchment like covering which remained adherent to the cranium and under which healing took place without complications . . . in such a case the reapplication is practically only a dressing with the skin."

The case to be reported was treated in a similar way. Approximately 75 per cent of the graft appeared viable after four weeks of observation. Shortly after a month, however, the surface of the graft assumed a brownish, dried out, tanned, contracted appearance. Eventually, the graft separated spontaneously yielding a granular base covered by a moderate purulent discharge. The granulations completely filled the defect. No temperature elevation or complication ensued. The reapplied scalp acted merely as an excellent protective dressing preserving the pericranium and allowing normal granulations to form.

Most reports in the literature describe reappplied scalps as becoming necrotic, infected and malodorous necessitating their

nium." After the tan is removed, the granular surface should be surgically prepared for grafting. In this case the wound



FIG. 3. A, B, C, D and E, end result after skin grafting; two small anterior ulcers are evident.

removal. Others report their conversion into a parchment-like covering. Davis,<sup>5</sup> in his animal experiments, concluded "that granulations appear to grow well on the periosteum under the reappplied flap. For this reason alone then, the scalp might be replaced in toto after proper cleaning and free drainage, and if carefully watched and removed at the proper time would not cause infection, and might stimulate the growth of granulations on the pericra-

was dressed daily with a thin coating of sulfathiazole powder and a continuous wet pressure dressing of 1:3300 aqueous azochloramide for five days prior to grafting. The purulent discharge disappeared and the granulations became firmer and yellowish in appearance. A thin split-thickness graft was employed in this case. However, I believe a thick split-thickness graft would have been more suitable. The graft was cut, trimmed to pattern, and placed over the

defect. The best method of immobilizing the graft is to suture it either by the end-to-end or overlapping method to the periphery of the defect by a continuous running thin catgut suture. This is supplemented by interrupted heavy black silk sutures. Vaseline gauze and several additional thicknesses of gauze are then placed over the graft and the sutures tied. (Fig. 1.) Exuberant granulations or an unhealthy appearance of the granular layer may easily be corrected by repeated applications of a saturated solution of trichloroacetic acid, vaseline gauze and a pressure dressing. Only gross manifest infection should delay grafting. However, when the granulations maintain a satisfactory appearance, grafting should be started. My recent experiences in grafting severely burned patients with marked infection have shown tissue culture to be unimportant. Wounds from which hemolytic and non-hemolytic streptococci, *Bacillus proteus*, *Staphylococcus aureus* and *albus*, have been isolated have accepted Thiersch and split thickness grafts well. If the granular surface appears healthy, it should be grafted in spite of a positive culture. It is also maintained by some authors that skin grafts will not take in patients whose hemoglobin or plasma protein level is low. I have found skin grafts to take well in spite of this. In severe extensive burns with marked toxemia, grafting has been highly successful even with the hemoglobin as low as 29 per cent and the plasma protein level at 5.3.

Mitchell<sup>8</sup> uses a sliding flap technic in avulsion cases. He advocates making numerous parallel relaxation incisions down to the pericranium. Several advancement flaps are thus formed, mobilized, shifted medially and approximated by tension sutures. The raw surfaces are allowed to granulate in and multiple operations are required. This procedure is only suitable for small and moderately sized defects.

Otto<sup>9</sup> describes the, "Great degree to which the remaining scalp may be stretched, if mobilized and drawn together in multiple stages allowing sufficient inter-

val for compensation in the marginal scalp."

New and Erich<sup>10</sup> describe a method of,



FIG. 3E.

"reconstruction of lost portions of the scalp by employing hair-bearing pedicle scalp flaps. Unfortunately, such grafts have a limited degree of usefulness since they may be applied, in general, only to defects of comparatively small dimensions."

The defect may be thoroughly cleaned, treated with sulfa powder, packed with vaseline gauze and allowed to granulate in. Earlier surgeons began grafting immediately, placing the grafts directly upon the pericranium. This technic may be successful in many cases but has little or no advantage. The wound should be conservatively treated until the granulations have filled in the defect. Then after surgical preparation, it is ready to graft.

2. *Pericranium Destroyed.* If the pericranium shows a small tear or is only partially destroyed, the remainder may be elevated from the skull, the defect sutured, and treated as though the pericranium were intact.

If the scalp defect is small or of moderate size, a sliding advancement or rotation

flap consisting of the skin and superficial fascia may be used to cover the insufficiency. The remaining defect can then easily be skin grafted.

it." (2) Multiple small holes may be drilled through the outer table of the skull down to the diploe. Granulations will then grow through these holes filling in the defect.



FIG. A, B, C and D, patient with prosthetic hairdress manufactured from her own salvaged hair.

If the pericranial defect is very large, either of three methods may be employed: (1) Davis<sup>5</sup> advocates dressing "the uncovered bone with wet dressings, so that it will not dry out and become necrotic. A piece of rubber protective over the denuded bone will also keep the bone moist until the granulations have formed over

Rylander and Kisner<sup>11</sup> reported the case of a patient treated thusly and stated that granulations appeared twelve days after drilling and the wound was ready for grafting in fifty days. (3) A pedunculated flap may be taken from the back and transferred to cover the skull defect as advocated by Roberts<sup>12</sup> and Cahill.<sup>13</sup>

## SELECTION OF GRAFT

With the advent of the dermatome, large defects such as those caused by scalp avulsions, are no longer a problem. If a clear healthy appearing granular surface is present, the most suitable type of graft is a thick split-thickness dermatome graft. If the granulations do not appear healthy or a moderate granular discharge is apparent, a satisfactory result may be obtained by employing a thick Thiersch graft. A full thickness graft is ideal. However, the possibility of a complete take is less and the resultant donor defect is greater than the aforementioned types of graft. The thicker the graft, the lesser the tendency toward ulceration. Small recurrent ulcers may occur in Thiersch or split-thickness grafts, but these are not permanent and heal in short periods of time. In the case to be reported, two ulcerations occurred at the anterior part of the scalp which resisted therapy for several weeks. However, by compressed air therapy and a 5 per cent scarlet red ointment, these ulcers healed satisfactorily.

## CASE REPORT

Miss M. C., single, age twenty-one, was employed in a defense plant as a layout worker. On October 30, 1943, having none of her own duties to perform, was transferred to operate a drill press. As a layout worker, it was unnecessary to wear a protective covering on her hair. While operating the press, her hair became entangled in the machine behind her. She was pulled upward and backward toward the machine. The patient was knocked unconscious and the scalp completely avulsed. She then fell forward freeing herself from the machine. The patient has no recollection of the accident and the first thing remembered is being helped away from the press. A fellow worker then shut off the machine. Upon gaining consciousness she experienced a great deal of pain and felt as if the "top of her head were missing." Severe bleeding ensued. A towel was wrapped around the head and the patient taken to St. Elizabeth Hospital, Elizabeth, N. J.

Upon admission to the hospital the patient was fully conscious and in a slight state of shock. Her general condition was good. The

blood pressure reading was 90/50, pulse rate was 105 per minute, and the temperature was normal. Radiographs revealed no fracture. Neurological examination revealed no abnormality. The pupils reacted to light and accommodation, and the eye grounds were normal. Examination revealed a scalp defect measuring eight inches square. The line of tear began one inch behind the normal forehead hair line and extended backward along the superior temporal line to the superior nuchal line. Multiple small lacerations and a linear laceration three inches in length extending downward over the right frontal region were also evident.

Dr. Thomas J. Walsh, attending surgeon, retrieved the scalp in five pieces. These were shaved, surgically cleaned, and washed in normal saline. Sulfathiazole crystals were sprinkled into the wound and the scalp pieces placed *in situ*, jig-saw puzzle fashion. They were sutured without paring. No elevation of temperature or pulse occurred and the blood pressure returned to a normal of 120/80 following the operation.

November 3, 1943, the patient complained of severe pain in the scalp with a throbbing headache. The wound was clear and sedatives were administered.

November 27, 1943, a copious purulent discharge was present around the periphery of each graft. Necrotic areas were also present in this region. Approximately 75 per cent of the grafts had a pinkish coloration and appeared viable. In the following weeks, the grafts became darker assuming a tanned appearance. Eventually, large dried tans formed. They separated spontaneously yielding a granular base on a level with the remaining intact scalp. The granulations were covered with a moderate discharge.

January 15, 1944, the wound was treated by daily applications of sulfathiazole powder and continuous wet 1:3300 azochloramide pressure dressings.

January 21, 1944, a .016 inch dermatome graft was taken from the abdomen and placed upon the granulations. The margins of the graft were attached to the scalp by a continuous running suture of No. 00 plain catgut. Heavy black silk sutures were then placed and tied over several thicknesses of gauze. A stable pressure dressing was thus formed. The graft took well and the patient was temporarily



discharged from the hospital on February 4, 1944.

February 12, 1944, the patient was readmitted to the hospital and another .016 inch dermatome graft was taken from the abdomen, cut to pattern, and sutured into the remaining defect. The patient was discharged from the hospital on February 16, 1944.

Healing was satisfactory with the exception of a few small ulcerations which appeared from time to time. Two ulcers on the anterior portion of the scalp resisted treatment for a period of a month. Finally, however, under compressed air therapy and the application of a 5 per cent scarlet red ointment, these two healed satisfactorily.

After exposure to air, the graft, which was first livid white in color, assumed a healthy pinkish glow and blood vessels could be seen growing into the graft. Sensitivity is slowly returning from the periphery inwardly.

Fortunately, all of the avulsed hair was salvaged and employed in the manufacture of the prosthetic hair dress. A small piece of cloth is worn under the hairdress and changed daily. The patient's mental outlook is excellent. (Figs. 2, 3 and 4.)

#### CONCLUSIONS

A totally avulsed scalp may be reapplied to the head after proper surgical preparation and serves as an excellent protective dressing preserving the pericranium and allowing normal granulations to form.

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# PYOPNEUMOTHORAX IN THE FIRST MONTH OF LIFE WITH RECOVERY\*

## TWO CASE REPORTS

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THERE has been much discussion in the literature concerning empyema in children. The general conclusions are that it differs little from the ordinary adult type. Thus it is most frequently a sequel to pneumonia. Before the wide use of sulfa drugs, the most common causal organism was the pneumococcus,<sup>2</sup> but in recent years there has been a shift toward the staphylococcus. Hochberg and Steiner,<sup>4</sup> in a study of nineteen necropsies of children less than three months of age dying with empyema found the staphylococcus in 67 per cent of their cases, the streptococcus in 25 per cent and pneumococcus in 8 per cent. Most of these children had an associated widespread bronchopneumonia.

It is usually considered that mortality in infants is higher than in the older age groups. Mitchell<sup>8</sup> states that the mortality of empyema in children under one year of age is 50 per cent. Lanman and Dimmler<sup>5</sup> state that in the period from 1919 to 1934 their mortality rate in children under two years of age was 35 per cent. From 1934 to 1939 this rate dropped to 4 per cent. They attribute this to more intelligent management with closed drainage being the basis of treatment. Hochberg and Kraemer<sup>3</sup> in their analysis of 300 cases of empyema in children found a mortality rate in the first six months of life of 58 per cent.

As far as can be ascertained from a diligent search of the literature, empyema in infants under one month of age is an unusual condition, and it seems that the younger the infant the higher the mortality and the more difficult the management.

Therefore, we believe that the following case reports present an unusual and interesting problem.

## CASE REPORTS

CASE 1. R. S., referred by Dr. John B. Bartram, was admitted on January 31, 1943, because of coughing, grunting respirations and fever. The baby was born in Temple University Hospital four weeks previously at a normal delivery. It was said by mother to have a "slight cold" when born, but the pediatrician could find no evidence of respiratory infection. No x-ray was taken. About ten days to two weeks before, respirations were somewhat grunting. About three days before admittance respirations became moderately labored and the baby seemed to be ill. Shortly before admission, it became short of breath, respirations were quite noisy, its color became dusky and temperature was elevated. The baby had been feeding from breast and was taking feedings well until two days previously when it seemed to become tired after a few minutes feeding.

Physical examination revealed the nutrition good but the child appeared critically ill. Respirations were 80 to 90 and quite labored. The skin was dry and there was a dusky, purplish-red cyanosis and marked retraction of interspaces on inspiration. Breathing was shallow, rapid, and most ineffectual. The heart was shifted markedly to left. Fine rales over both lung fields were heard. There was very little respiratory excursion on the right. Dullness to percussion over entire right side of chest was present.

The laboratory report revealed red blood cells 3.80, white blood cells 30,350, polymorphonuclears 76 per cent, non filaments 68, filaments 8, hemoglobin 12.5 Gm.

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X-ray on admission revealed complete pyopneumothorax on the right with marked shift of mediastinal structures to left almost obliterating the left lung. (Fig. 1.)



FIG. 1. X-ray of baby R. S. on admission. Note degree of mediastinal shift and presence of fluid and air in right pleural cavity.

Immediate aspiration of moderately thick gray pus and air from right thorax, gave some

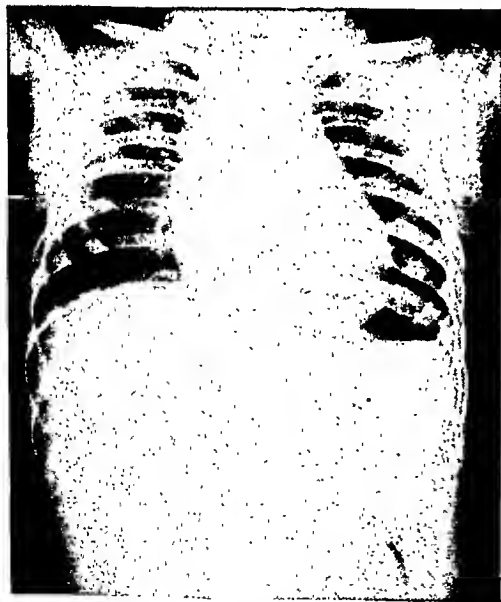


FIG. 3. X-ray of baby R. S. approximately one year later showing normal chest.

relief. Culture revealed hemolytic staphylococcus aureus. Under local anesthesia immediate closed intercostal drainage was done on

right side using trochar and canula. Relief was rapid. Suction of 30 cm. of water was applied to intercostal tube. X-ray the following day, February 1, showed much less fluid and air in



FIG. 2. X-ray of baby R. S. five days after rib resection and closed drainage with constant suction. Note marked improvement as compared with Figure 1.

the pleura and the baby was much improved. Sulfadiazine by mouth, 6 gr. per day for six days, was given. Improvement continued. X-ray two days later, (Fig. 2) showed loculated anterior collection with mediastinal structures in normal position. Clinically, the baby seemed excellent. On February 4th, this undrained collection was drained under local anesthesia through a rib resection located just anterior to the site of the intercostal drainage.

X-ray on February 5th, confirmed the thought that surgical drainage seemed satisfactory. At this time a small radiolucent area was first seen which appeared to be within the substance of the right lower lobe. However, improvement continued and the empyema cavity gradually became smaller until February 16th, sixteen days after admission, the drainage tube was entirely removed after x-ray on February 15th had revealed no pleural space demonstrable and the radiolucent area in the right lower lobe showed no change.

The baby had an occasional cough, but otherwise seems to be entirely normal. He was discharged from the hospital on February 21st, twenty-one days after admission,

Before discharge, it was decided that the cyst-like area in the right lower lobe should be watched carefully both clinically and by x-ray.

much worse on March 31st when it was admitted to Temple University Hospital.

Physical examination revealed definite dysp-



FIG. 4. X-ray of baby M. K. on admission. Note large amount of air and total collapse of lung with the presence of fluid, and extreme degree of mediastinal shift.

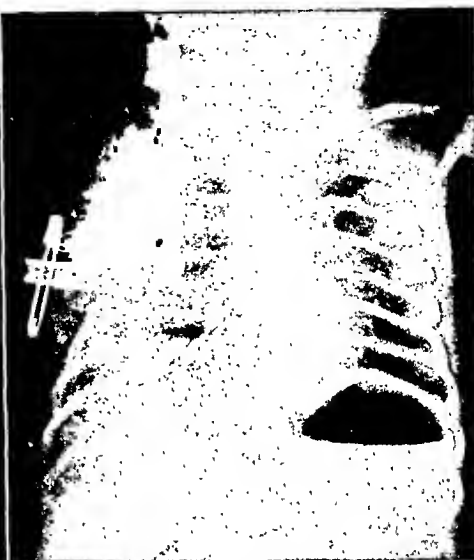


FIG. 5. X-ray of baby M. K. eleven days after rib resection had been done at the time of conversion to open drainage from closed drainage with constant suction.

It was believed that this area represented one of three things: a pulmonary cyst, a persistent pulmonary abscess, or a loculated empyema.

He was readmitted on March 3, 1943, eleven days after discharge, with a slight cough and a temperature of 101°F. (rectal), white blood cells, 17,900 with 73 per cent polymorphonuclears and x-ray revealed persistence of the cyst. Aspiration of a few drops of fluid and several cc. of air from previously mentioned cyst-like area was followed by immediate relief of fever, cough, and leucocytosis. His course was normal for four days when he was again discharged. No further symptoms occurred in eighteen months of follow-up. X-ray check-up on January 14, 1944, revealed no abnormality. On July 26, 1944, he was entirely normal in every way. (Fig. 3.)

CASE II. M. K., a white male, age three weeks, referred by Dr. Norman Kendall, was admitted on March 31, 1944, because of grunting rapid respirations and cyanosis.

The baby had been born three weeks previously in Temple University Hospital after a normal uneventful delivery. It was perfectly well until March 29th when it seemed restless and fretful. On March 30th rapid respirations were noted with fever. The infant seemed

neat and cyanosis. Temperature was 103°F., pulse 120, respirations 55. Examination was normal except for the chest. Expansion was markedly diminished on the right; breath sounds were markedly diminished on the right and exaggerated on the left. Moderate dullness to percussion was noted on the right. No râles were present.

X-ray showed complete collapse of the right lung with marked shift of mediastinum to the left and the presence of fluid and air. Aspiration revealed creamy pus and air under positive pressure. The white blood count was 23,200 with 54 per cent polymorphonuclears, all immature.

A rib resection was done immediately under local anesthesia, removing about 2 cm. of the right fifth rib in the mid-axillary line, and a mushroom catheter was inserted for closed drainage with constant suction of 2" of vacuum by motor driven pump.

Culture taken on admission showed pure culture of non-hemolytic staphylococcus aureus, pathogenic strain (aerobic and anaerobic culture). This organism was also found in cultures from the nose and throat on that date and from a blood culture taken April 1st. On that day, after culture had been reported,

penicillin was begun and continued as follows: 1 cc. every four hours into drainage tube which was clamped for the next two hours. This was



FIG. 6. X-ray of baby M. K. one month after discharge showing normal chest. (X-rays taken by Dr. W. Edward Chamberlain, Temple University Hospital, Philadelphia, Pa.)

continued for eleven days. One cc. intramuscularly every three hours was given for eighteen days, when the dose was changed to 2 cc. intramuscularly every two hours and continued for seven days.

Three days after closed drainage was instituted the condition was much improved with a fall in the respiratory rate and loss of cyanosis. Four days after drainage the temperature reached normal although positive cultures of the staphylococcus were still being obtained from the drainage. One week after drainage the baby was doing very well despite the fact that *Bacillus pyocyaneus* was found on cultures from the drainage tube. On April 11th, or eleven days after drainage, conversion to open drainage was instituted. Two weeks after drainage, despite the fact that the temperature was normal and the baby looked very well, a few *Staphylococcus aureus* were found in the culture. All subsequent blood cultures were negative and the baby was gaining weight in a normal fashion. On May 3rd, twenty-nine days after admission the child was discharged, after having had a normal temperature for two weeks. The drainage tube had been entirely removed four days previously and the last culture from the incision showed a few *Bacillus pyocyaneus*.

Between the period from April 11th to April 20th the child gained 1 pound 8 ounces.

In addition to the penicillin, other therapy consisted of 70 cc. blood transfusion on April 18th and 60 cc. the following day. These were given because of anemia. Also vitamins were given and adequate feedings were maintained by mouth. Oxygen was used for the first two weeks as needed.

At no time did the baby appear extremely ill after drainage was instituted. X-rays taken every week in the hospital showed steady expansion of lung and clearing of pneumonitis.

On May 18, 1944, the baby was in excellent condition and the external drainage wound was entirely healed. X-rays of chest were taken for check-up and revealed an entirely normal chest.

#### COMMENTS

It may be noted in these case histories that the most striking clinical feature was the rapidly progressive dyspnea. This was due to pressure pneumothorax which had not only caused complete collapse of the lung on the involved side but was also interfering with aeration of the opposite side, the result of mediastinal shift. Thus it was necessary to institute immediately some form of adequate closed drainage so that physiological pulmonary function could be restored.

In Case 1, the child was in extremis on admission. Immediate intercostal closed tube drainage with suction was done in the room as a life-saving measure. Adequate drainage could not be maintained by this method due to the narrowness of the interspaces, and it was necessary to do rib resection later.

Baby M. K. was treated by immediate rib resection with closed drainage and constant suction. Adequate drainage was maintained and we consider this later method as preferable. Naturally, open drainage which has been widely advocated as the treatment of empyema in children, was not to be considered in these cases due to lack of loculation or fixation of mediastinal structures.<sup>1,9,10</sup>

Baby R. S. received sulfa drugs by mouth. The cavity was obliterated entirely

and the drainage tube was removed in sixteen days.

Baby M. K. received penicillin locally and intramuscularly. The drainage tube was removed in twenty-nine days. This child had a positive blood culture on two occasions. We might attribute the prolongation to *Bacillus pyocyaneus* as a local bacteriological complication decreasing effectiveness of penicillin.

The reason for pyopneumothorax in both of these cases can be given only by supposition. We are inclined to believe that the only logical explanation is the sequence of a staphylococcic pulmonary infection with abscess formation and perforation into the pleural cavity. The possibilities of congenital areas of localized emphysema or small pulmonary cyst with rupture into the pleural cavity cannot be definitely ruled out.

#### COMMENT

1. Pyopneumothorax in infants is less frequent but much more serious than the usual empyema in children.

2. Two such cases occurring in the first month of life are presented in which immediate closed drainage was a life-saving

procedure. Both infants are now in excellent health.

3. We believe the etiology of the condition to be staphylococcic pulmonary infection with abscess formation and perforation into the pleural cavity.

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# INTRACTABLE PEPTIC ULCER

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**I**MMEDIATE results in attempts to evaluate various treatments of peptic ulcer may be deceiving because of the spontaneous remissions that characterize the disease. Remote results, preferably after ten years, must be studied before one may speak with any degree of confidence regarding the value of a certain type of treatment.

This contribution is a follow-up of a case reported in 1938<sup>3,4</sup> a summary of which follows:

In 1927, the first operation, (at seventeen years of age) consisting of appendectomy and gastroenterostomy for duodenal ulcer was performed. He was symptom free for five years. In 1932, he had an acute massive hemetemeses. The second operation, degastroenterostomy, excision of jejunal ulcer and new gastroenterostomy were performed. He was relieved of symptoms for two years. In 1934, he had another acute massive hemetemeses. A third operation, entero-enterostomy was performed with no relief of symptoms. In 1937, he had another massive hemetemeses. His ulcer symptoms continued. He consulted the author for the first time in 1938.

Diagnosis of jejunal (stomal) ulcer was confirmed by x-ray. On September 4, 1938 fourth operation was performed by the author. Excision of jejunal (stomal) ulcer with proximal partial gastrectomy (fundusectomy) was performed. His convalescence was prompt and there was marked improvement with a gain of twenty-one pounds' weight in four months.

The symptom free interval lasted until April, 1939, when an attack of flu was followed by another acute massive hemetemeses, but with very few gastric symptoms. In May, he had a severe dermatitis of undetermined origin. During the summer he was practically symptom free. In October, gastric symptoms returned, obstructive in type, with nausea,

vomiting and gas. There was no hemetemeses. A test meal showed hydrochloric acid present 16, 24, 26 and 30 per cent.

On November 20, 1939, a fifth operation revealed a large ulcer one inch in diameter at the pylorus, buried in firm adhesions. (This ulcer was probably present at the time of the removal of the stomal ulcer in 1938.) Resection of the ulcer with gastroduodenostomy was performed. The gallbladder was adherent to the stomach and contained no calculi, but was drained. Convalescence was satisfactory with discharge from the hospital on January 12, 1940, with a gain of eight pounds in weight. There was gradual improvement and a symptom free period lasted until June 6, 1943, when he met with an indirect, accidental abdominal strain which was followed by pain, swelling, tenderness and impulse on coughing in the scar of previous operations. The acute swelling soon subsided, but localized induration, tenderness and rigidity, with constant gastric symptoms, persisted. A test meal showed hydrochloric acid not present in fasting stomach contents; post meal it was present 32, 33, 36, 20 per cent. X-ray showed "a filling defect at the pylorus."

Despite "medical management" symptoms persisted and on January 20, 1944, a sixth operation was carried out: The proximal stomach was small and adherent to the spleen, colon and diaphragm. The distal stomach, duodenum, colon and omentum were in a mass four inches in diameter and adherent to the liver and anterior abdominal wall. Exploration of this mass revealed a peptic ulcer one inch in diameter with a necrotic base and indurated margins. This ulcer was resected with a six inch triangle of proximal stomach and gastrointestinal continuity re-established by another atypica gastroduodenostomy. For the purpose of postoperative decompression and feeding a jejunostomy was performed. The ventral hernia was repaired in closing the abdominal incision.

His postoperative course was very satisfactory until the jejunostomy tube was removed on the tenth postoperative day, after which gastric obstruction necessitated on February 12, 1944, a seventh operation which was a rapid anterior gastrojejunostomy. Because of the many adhesions, the only suitable stomach was located very high near the diaphragm which called for a long loop of jejunum. This is, of course, not a desirable location for a gastrojejunal stoma, especially so in an individual with a history of intractable peptic ulcer, but no other procedure seemed practical under the circumstances and the local condition.

His postoperative course to date (April 9, 1945) has been satisfactory. The patient has gained weight, is comfortable and without "stomach distress or pains."

The final result is, of course, unknown and the prognosis must be guarded, but this case would seem to emphasize the advisability of removing a substantial amount of the acid secreting proximal stomach in recurrent or intractable peptic ulcer cases, which might be likened to the necessity of subtotal thyroidectomy in hyperthyroidism. It should be remembered that any type of surgical treatment is but an incident, often a most important incident, between preoperative and postoperative management.

In the treatment of peptic ulcer, the pendulum of opinion has swung from non-operative to operative and now again to non-operative as duodenal ulcer is considered to be a general disease with a local lesion, usually amenable to non-surgical management; except with complications: perforations, organic obstruction (perhaps hemorrhage under certain circumstances) and intractability.

In the surgical treatment, gastroenterostomies and pyloroplastics have been superseded by resections, first local excision of the ulcer, then pylorotomy, then resection of the "ulcer bearing area," then partial gastrectomy and at present this shift to the left has extended to subtotal gastrectomy, the presently accepted surgical treatment of peptic ulcer.

This procedure is objectionable in that

it is mutilating, it sacrifices the important pyloric sphincter mechanism and the protective alkaline mucous secreting distal stomach.

It is based upon two fundamental objectives (1) minimizing the acid secreting fundal mucosa and (2) removing the antral mucosa. The former is a generally accepted principle of surgical treatment and will probably remain so until a remedial or removable cause of the hyperchlorhydria is discovered, or until a clinically applicable antisecretagogue is developed.

The latter is based upon "Edkin's Theory" that the antral mucosa secretes a hormone "gastrin" that stimulates secretion of hydrochloric acid in the fundus. This concept has not been proved, either experimentally or clinically and confusion exists between gastrin and histamine.<sup>2,5</sup>

Pylorotomy and antrumectomy, in which antral mucosa is removed, have not always been satisfactory.

Granting the existence of "gastrin" as an acid secretory stimulant removal of its source, the antral glands, may be compensated for by the Brunner's glands of the duodenum which differ from the antral glands chiefly in the relationship to the submucosa. Without such compensation other stimuli, i.e., psychic, gastric mechanical, and intestinal, may maintain hypersecretion, it would therefore seem that the possible advantage of removing the antral mucous membrane is of questionable value and would be more than offset by the mutilation in loss of sphincter action and alkaline secretion.

In 1929, the writer<sup>6</sup> suggested a modified type of resection which retained the desirable features and obviated the above objections to subtotal gastrectomy in treatment of non-obstructing duodenal ulcer.

The last word in treatment of intractable, or complicated peptic ulcer has probably not been spoken. That a trend in the direction of less extensive operations may be developing is to be seen in the studies of Heuer and Holman,<sup>7</sup> who state there are



probably other factors than the diminution of hydrochloric acid to account for the satisfactory results that often follow mutilating operations. (On the other hand it must be remembered that in the absence of hydrochloric acid, *peptic* ulcer does not occur.)

Andrus, Lord and Stefko<sup>1</sup> report favorable experimental and clinical results following a new surgical procedure in which a jejunal flap is transplanted into the stomach wall.

The numerous surgical attempts to reduce gastric acidity are, of course, merely symptomatic and not radical treatment. The exciting cause of the hyperacidity, probably a variable non-constant factor, unfortunately as yet unknown, may remain active.

Recently attention has been given to the neurogenic etiology of peptic ulcer; but division of the vagus with consequent sympathetic preponderance has not been followed by satisfactory results.<sup>8,9</sup> On the other hand one finds in the voluminous literature little mention of increased peptic ulcer symptoms after sympathectomy.

Medical management, non-operative treatment, has also passed through many changes that included practically all possibilities and many impossibilities.

Dietotherapy has shifted through all gradations from feeding (Lenhartz), empty stomach and light diet (Sippy) and back to feeding (Meulengracht).

The antacid soda treatment has still a very large following (as is also true of all symptomatic treatments), but there seems

to be a definite trend away from neutralization and toward hydrochloric acid binding chemical substances and a definite increase in the popularity of less medication, except for sedatives or antispasmodics, with frequent small feedings, balanced rest and exercise, and emotional and environmental controls.

The final perfect ideal treatment will probably be non-operative medical management which must await development of a clinically applicable antisecretagogue, similar to the "entrogastrene" or "urogastrene" of Ivy.<sup>10</sup>

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# LYMPHANGIOMA OF THE ABDOMEN

## AN UNUSUAL CASE

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**A** LYMPHANGIOMA is generally described as a tumor composed of lymph vessels and spaces containing lymph. It was apparent from the survey of the

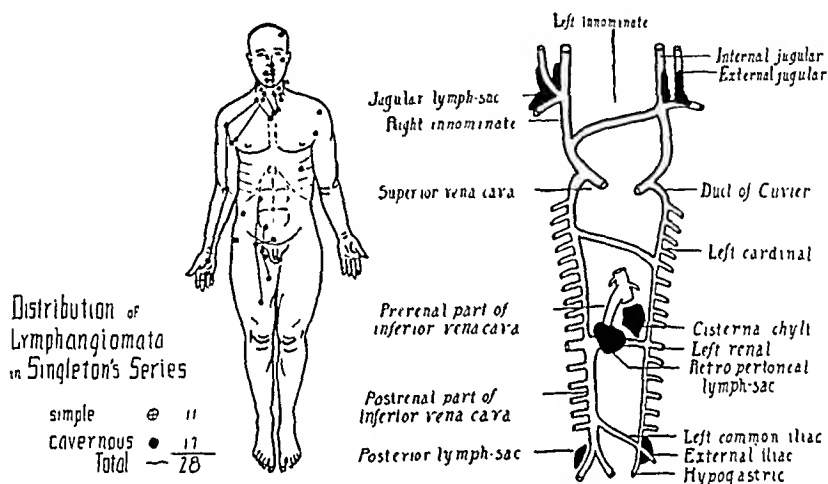


FIG. 1. The diagram on the left illustrates the distribution of lymphangiomas in Singleton's series (after Singleton); the diagram on the right, the distribution of the lymph sacs in the embryo (Gray's Anatomy after Sabin).

lymph. It consists of the endothelial cells and the supporting tissue elements of the lymphatic system which are involved in a neoplastic process.

The lymphangiomas include a variety of slow-growing, usually congenital, single or multiple tumors involving chiefly the skin, subcutaneous and deep areolar tissues of the lips, tongue, neck, mediastinum, axilla, mesentery, omentum, retroperitoneal or sacral regions. Wegner's<sup>2</sup> original classification of lymphangiomas as simple, cavernous and cystic is commonly accepted. Watson and McCarthy<sup>3</sup> have added two divisions to this classification: cellular or hypertrophic lymphangioma and diffuse systemic lymphangioma, which

literature that there is still considerable confusion and lack of uniformity in the nomenclature and diagnoses of the lymphatic neoplasms. Even in the case report to be presented several diagnoses were ventured among a group of prominent pathologists from several medical colleges.

The great majority of the abdominal lymphangiomas reported in the literature have involved the omentum. About eighty-seven such cases have been reported.<sup>3,5</sup> All of these have been of the cystic type—unilocular or multilocular. Occasionally they have attained a considerable size, the largest reported weighing seventy-five pounds.<sup>4</sup> Most of them were discovered prior to adolescence but in several in-

stances they had gone unnoticed until middle age. The sex incidence was about equal. A correct diagnosis was seldom made prior to operation. The operative mortality

siderable support to this theory. The fact that they are slow growing and benign may explain why they may go unnoticed until adult life.

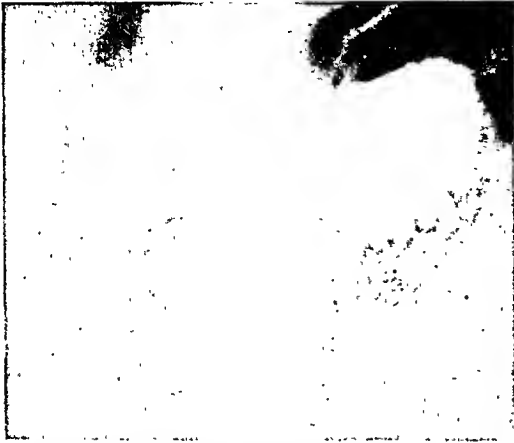


FIG. 2. Preoperative roentgenogram of stomach showing large filling defect of greater curvature and downward sweep of pylorus and duodenal cap.

was very low. These tumors are considered as being essentially benign and do not tend to recur if completely removed.

The retroperitoneal and mesenteric lymphangiomas appear to have occurred much less frequently. About ten cases have been reported in the literature.<sup>6,7</sup> All of these have been of the cystic variety excepting one which was of the cavernous type and resembled the one to be described in the case report to follow. The tumors in this region may be a mixture of the cavernous and cystic types. The retroperitoneal types originate along either side of the spinal column and frequently extend posterior to the colon, downward into the pelvis, upward toward the liver or anteriorly into the mesentery or the omentum.

Several theories have been advanced to explain the etiology of lymphangiomas, the more plausible one being the embryonal one. According to this theory these tumors arise from small segments of lymph tissue retaining their embryonal characteristics locally. The fact that lymphangiomas occur more frequently near the primitive centers of origin (Fig. 1) and are more common clinically in children lends con-



FIG. 3. Preoperative position of small bowel, showing marked distortion and displacement of entire small bowel into right upper quadrant.

#### CASE REPORT

The patient, a white male, aged thirty-five years, an officer in the Armed Forces, entered the Station Hospital on January 4, 1944. The chief complaint at the time of admission was a dull aching pain in the left upper quadrant which had been present since December 19, 1943. On the evening of that date this officer was returning home in a jeep after a day of very strenuous activity when he suddenly noted a sharp stabbing pain in his left hypochondrium. The patient felt that the pain was either the result of his arduous day's work (carrying goats) or caused by riding in a jeep over rough terrain for fifty miles. Despite the pain he rested well that night and was told by the attending medical officer to remain in his quarters on the following day. The abdominal distress became dull in character, no radiation was noted and the patient was free of any gastrointestinal signs or symptoms. On December 21,

1943, because of persistent pain, he was first admitted to another hospital. A diagnosis of hemorrhage into the abdominal wall was made

and decidedly protuberant abdomen in which a firm mass could be felt in the left upper quadrant. The mass was smooth and its margins



FIG. 4. Preoperative roentgenogram showing filling defect and displacement of descending colon.



FIG. 5. Preoperative excretory urogram showing marked medial curve of the left ureter and downward displacement of the left kidney.

and the patient was discharged to light duty in three days. However, the pain continued and seemed to be aggravated by walking, bending, and laughing. On January 4, 1944, this officer returned to his regular military post and was admitted to this hospital for further study and treatment.

A careful history failed to elicit any abnormal gastrointestinal or genitourinary signs or symptoms. The patient had an excellent appetite and had gained weight recently. Since 1935, he had noted a very gradual increase in weight and abdominal girth. While undergoing army basic training in 1942, the patient lost forty-five pounds. Some of this he regained subsequently and during the past ten months had gained twenty pounds. His waist measurement had increased about four inches during this time. His past general health otherwise had been remarkably good and he had passed several rigid physical examinations while in the army. The family history was non-contributory.

The general appearance of the patient was that of a well developed and well nourished white male who was apparently in excellent health.

Physical examination revealed a symmetrical

were difficult to outline; however, it was considered to be about the size of a large grapefruit. A small area of tenderness was present where the mass extended beneath the left costal margin. Dullness was noted over the entire abdomen and the presence of ascites was considered likely. The mass did not move with the respiratory excursion and the abdominal viscera could not be palpated. Rectal examination was negative. His weight was 181 pounds and the remainder of the examination revealed nothing positive.

Laboratory studies were repeatedly found to be normal. A complete hematological survey including blood counts, smears, serological and immunological reactions, bleeding and clotting time, sedimentation rate and blood chemistry studies, was made and all examinations were reported as normal. Urinalyses, stool examinations and a tuberculin test gave negative results.

Roentgenographic studies, however, were extremely interesting. Examination of the upper gastrointestinal tract revealed an elevation and partial inversion of the stomach. (Fig. 2.) The greater curvature was deformed

by a large, smooth, rectangular, filling defect produced by an extrinsic mass. The duodenal sweep presented a J-shaped configuration



FIG. 6. Preoperative chest roentgenogram showing elevated diaphragm and atelectatic band in left lung field probably the result of compression.

instead of the normal C-shaped appearance. (Fig. 3.) The distal part of the duodenum and all of the jejunal loops were displaced into the right upper quadrant. The appearance of the stomach and loops of small bowel suggested a congenital anomaly,—failure of rotation of the small bowel.

A barium enema revealed the entire descending colon to be pushed toward the midline. (Fig. 4.) A crescent-shaped filling defect on the lateral aspect of the descending colon suggested pressure by an extrinsic tumor. Intravenous pyelograms clearly indicated that the left kidney was lower than the right and the left ureter was displaced toward the midline in a rather precipitous curve (Fig. 5). Examination of the chest revealed an elevated diaphragm, the left dome being almost as high as the right. (Fig. 6.) A rather dense, band-like oblique shadow was noted in the left lung field extending to the lateral chest wall. This was considered either a thickened interlobar fissure or a focal area of atelectasis as a result of restricted motion of the diaphragm due to increased intra-abdominal pressure.

On January 27, 1944, an exploratory laparotomy was performed through an extended left

upper rectus incision. The peritoneum was opened and several hundred cc. of clear free fluid were aspirated. Immediately beneath the peritoneum there was an enormous encapsulated gelatinous tumor which was found to extend into every part of the peritoneal cavity from the pelvis to the diaphragm. The tumor was soft, jelly-like and a mottled grayish red in color. (Figs. 7 and 8.) A film of delicate adhesions connected it with the parietal peritoneum and viscera. The tumor was carefully mobilized and delivered, not without difficulty, onto the abdominal wall. The pedicle was relatively small and found to arise at the root of the mesentery where it was cut between double ligatures. The tumor weighed eighteen and one-half pounds.

The entire small bowel had been compressed posteriorly just below the liver, and the many loops of gut, being imprisoned in the right upper quadrant, had produced traction on the base of the mesentery. The abdominal viscera otherwise appeared to be quite normal. There were no metastases noted in the liver or elsewhere in the peritoneal cavity.

The patient was given 500 cc. of whole blood and 500 cc. of plasma while in the operating room and he was returned to the ward in good condition. The type of anesthesia was gas-oxygen-ether.

Following operation the patient made an uneventful recovery. On the fourteenth post-operative day he was again weighed and his abdominal girth measured. It was found that he had lost twenty-six pounds in weight and that his waistline was four and one-half inches smaller.

Roentgenographic studies were repeated during the patient's convalescence and it was noted that all of the viscera had once again assumed their normal positions and shape. The area of focal atelectasis had disappeared from the left lung field and the left dome of the diaphragm descended to its normal position. The small bowel had resumed its proper place and the stomach and duodenum were no longer deformed or displaced. Except for a small area of narrowing in the descending colon, the large bowel was normal. It was somewhat surprising to find that the left kidney and ureter had also returned to their normal positions. The left kidney was now higher than the right and the course of the left ureter was no longer curved.

The patient made an excellent postoperative recovery and was returned to duty in the Armed Forces. One year after the operation

philic material. These channels were lined with slightly flattened endothelial cells and were separated from one another by narrow well



FIG. 7.



FIG. 8.

FIG. 7. Gross specimen of tumor. Measurements are 60 by 25 by 10 cm., weight eighteen and one-half pounds.

FIG. 8. Cut section of lymphangioma showing well circumscribed nodules.

he was still free of symptoms and a G. I. x-ray series was found to be negative.

The pathological report revealed the following: The tumor consisted of a large, elongated and somewhat conical, jelly-like mass, measuring 60 by 25 by 10 cm., and weighing eighteen and one-half pounds. It was covered with a thin, smooth, glistening, vascularized capsule through which the tumor appeared dark reddish-purple in color. On palpation firm nodular masses could be felt throughout the tumor.

On section the tumor appeared to be myxomatous in character with numerous firm, grayish-white, well circumscribed nodules distributed throughout the structure, varying in size from 2 to 10 cm. in diameter.

Microscopically, the myxomatoid, intervening tissue structure was made up of large vascular channels filled with granular eosino-

defined septa. The nodular areas were very cellular, consisting of fairly closely packed spindle or polyhedral cells. In some areas there was relatively little stromal structure; in others the cells were definitely laying down connective tissue fibrils. The transition between the nodular areas and the myxomatous structure was very abrupt. In all sections small channels lined by endothelial cells could be seen. In some sections there was definite anaplasia of the tumor cells, but mitotic figures were rare.

The diagnosis of this tumor rests in part upon the interpretation of the significance of the vascular channels, depending upon whether these dilated lymph vessels are considered to be an essential part of the tumor or an unusual dilatation of pre-existing lymphatics. The diagnoses of a number of pathologists to whom sections of this tumor were sent for study were,

with one exception, divided between the diagnosis of lymphangioma and that of fibromyosarcoma. Detailed study is convincing that, even in the more cellular areas, minute endothelial-lined channels are being formed by the tumor cells, and that there is, consequently, a definitely endotheliomatous component of the tumor. However, as shown by special stains, other tumor cells in the same areas were definitely of a fibroblastic nature as indicated by the formation of intercellular collagen fibrils. This would lead to the conclusion that the tumor is of mesenchymatous origin, differentiating along both endotheliomatous and fibroblastic lines and leading to a diagnosis of lymphangioma, or, because of the possibility of malignancy, lymphangiofibrosarcoma.

For the most part, this tumor appeared to be benign in character. The areas of cellular anaplasia indicated that there was some chance of recurrence.

#### COMMENTS

Endothelial tissue tumors are not common and frequently are very difficult to classify. Of these ill defined tumors the lymphangiomas and particularly the solid cavernous or cellular type are *very* rare. A review of the literature failed to reveal a lymphangio-endothelioma combination similar to the case reported.

Endothelium lines cavities, and lymphangiomas show this lining of their lymph spaces, but these cells may also proliferate to form solid masses. Thus, it is often difficult to diagnose these tumors and a wide variance of opinion may be expressed by competent pathologists.

Microscopic sections and a gross description of the tumor herein reported were submitted for examination to ten leading pathologists both in the military service and at well known University clinics. These reports were noteworthy for their decided division of opinion between (1) lymphangioma and (2) fibromyxosarcoma. Perhaps this lack of uniformity is best understood by the chameleon-like properties of endothelial cells and the wide variety of tissue that may be included in a tumor of the lymphatic system. Although

the demarcation between innocent and malignant tumors is not a hard and fast line it is believed that this lymphangioma is a relatively benign tumor which may recur locally only after some years.

Perhaps the most bizarre findings in this case were the roentgenograms. The preoperative studies of the gastrointestinal tract were so distorted by the slow-growing, space-occupying tumor that the roentgenologist's interpretation was that of a congenital anomaly, failure of rotation of the small bowel. The large filling defect of the greater curvature of the stomach produced a partial inversion of that organ. Despite the fact that in man the entire duodenum is firmly anchored in position by the fusion of the parietal and visceral peritoneum, as well as the suspensory muscle of Treitz, in this case the position of the duodenum was so displaced that its normal C-shape was reversed to form a J.

The well marked curvature of the left ureter as outlined by intravenous pyelograms was most likely due to traction on the root of the mesentery. Normally, the ureter follows an almost vertical course downward on the anterior surface of the psoas major muscle. However, in its bed of areolar tissue it is closely related to the posterior peritoneum, adjacent to the root of the mesentery, is crossed by the mesocolon and may be displaced by traction on any of these tissues.

The fact that this massive abdominal tumor could not be palpated except in the left upper quadrant may be explained by pointing out that except for well circumscribed hard nodules (one of which was in the left upper quadrant) the entire consistency of the tumor was jelly-like.

#### SUMMARY

1. An unusual case of lymphangioma of the abdomen is reported. The tumor weighed eighteen and one-half pounds and measured 60 by 25 by 10 cm.
2. Attention is again focused on the relationship between the embryonal origin

of the lymphatic system and the sites of predilection for lymphangiomas.

3. The bizarre roentgenographic changes of the gastrointestinal and genitourinary tracts are carefully described.

4. The patient was operated upon, the tumor removed and following an uneventful recovery the officer was returned to military service.

The authors are indebted to R. L. Ferguson, M.D., Department of Pathology, Medical Research Laboratories, Edgewood Arsenal, Maryland, for his collaboration on the section pertaining to the pathology of this case report.

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There is no relation between the size of the tumor and metastases. Studies of lymph-nodes of the Gilchrist and David modification of the Spalteholtz method have shown that lymph-node involvement may be present even when the glands are not palpable. Also, those glands which are palpable may not be involved.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).



# ACUTE PHLEGMONOUS CECITIS\*

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IN 1943, Spivack and Busch<sup>1</sup> reviewed the literature and described two cases of primary phlegmonous cecitis, bringing the total number to thirty-seven. These authors divided the cases into two groups: the circumscribed and diffuse forms. They assumed that the disease starts as a suppurative process in the submucosa, terminating in one of the above two types. The organisms most commonly found were streptococci and staphylococci. *Bacillus coli* and pneumococci were also reported. The portal of entry for these organisms may be by the enterogenous or hematogenous route. The former may develop following abrasions of the mucosa as a result of foreign bodies, hard fecal material or worms in the lumen. The most common symptoms were those of elevated temperature, abdominal pain and vomiting. There was usually an elevation of the white blood cells, particularly the polymorphonuclear leukocytes. Physical examination in cases of phlegmonous cecitis disclosed a tender palpable mass in the right lower quadrant of the abdomen. The differential diagnosis from other surgical conditions in the right lower quadrant of the abdomen includes appendicitis, appendiceal abscess, tuberculosis of the cecum and regional ileitis involving the cecum. The presence of a tender tumor mass in the region of the cecum soon after the onset of symptoms is the best clue to a correct diagnosis. Treatment requires surgical exploration of the abdomen. A critical analysis of all cases by Spivack and Busch<sup>1</sup> suggests that for the localized form of the disease no further surgery should be done (although appendectomy was performed by many previous investigators). The diffuse type, however, requires an ileocecal resection.

Since 1943, there have been no other cases of primary phlegmonous cecitis reported. The following patient came under the observation of the present authors:

## CASE REPORT

W. F., a white adult male, age thirty-five years, was admitted to the South Nassau Communities Hospital on May 27, 1943. His chief complaints were pain and tenderness in the right lower quadrant of the abdomen of twelve hours' duration. The patient stated that for about twelve hours prior to the onset of the pain, he suffered mild distress in the epigastrium which radiated down to and localized in the lower right quadrant. The past history was entirely negative. Family history disclosed that two brothers were "bleeders."

Physical examination revealed nothing positive, except for the presence of a tender, palpable mass in the lower right quadrant in the region of McBurney's point. Urinalysis was entirely normal. The blood count on admission showed: hemoglobin 13.9 Gm., red blood cells 4,700,000, white blood cells 10,000, of which there were 75 per cent segmented neutrophils, 21 per cent lymphocytes, and 4 per cent monocytes. Temperature on admission was 99.6°F., pulse 106, respirations 20. A diagnosis of acute appendicitis was made and the patient was operated upon shortly after admission.

Under a general anesthetic a right rectus incision was made. The appendix was located and found to be injected but was obviously not the cause of the severe localized pain experienced by the patient preoperatively. Further exploration revealed a large, acutely inflamed mass in the cecum 4 cm. in diameter. The cecum was freely movable and was delivered into the abdominal wound without difficulty. It was dark red in color and along its medial aspect several large pink nodes were present. One of these nodes was excised for microscopic examination. The epiploic fat in

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the vicinity of the cecum was also dark red. Some of this tissue and the appendix were removed. The cecum was replaced and the wound closed in layers.

On the third postoperative day the temperature rose to 101°F., pulse 120, respirations 36. At this time the patient had abdominal pain. There was rigidity of the abdomen with rebound tenderness and distention. A diagnosis of spreading peritonitis was made. On the sixth day the temperature rose to 104°F., pulse 120 and respirations 30. On the seventh day sodium sulfathiazole was administered intravenously. The temperature gradually fell to a level of 100°F. The pulse remained elevated between 130 and 140 and the respirations were 20. On the tenth day a large, subcutaneous abscess in the line of incision was evacuated, and about 100 cc. of a foul serosanguineous, purulent exudate was obtained. This abscess was thought to communicate with the peritoneal cavity. The patient was given transfusions of whole blood and plasma but these failed to relieve the developing toxemia. He expired on the eleventh day after operation.

Microscopic examination of the appendix showed no acute inflammatory process. The mesenteric lymph node disclosed moderate hyperplasia of the follicles. The epiploic fat was congested and hemorrhagic.

At autopsy the positive findings were as follows: The abdomen appeared distended. A cigaret drain protruded from a right rectus operative wound in the abdomen. The heart showed extensive hemorrhage into the anterior wall of the pericardial sac. The heart was normal in size and weighed 300 Gm. There were no unusual changes found. The right pleural cavity contained about 400 cc. of a clear yellow fluid. About 200 cc. of a similar fluid were present on the left side. The lungs were lying free and had a combined weight of 1,600 Gm. The organs were grossly edematous but showed no evidence of pneumonia or other pathological processes. The trachea and bronchi were essentially normal. The peribronchial nodes were not enlarged. The abdominal cavity contained about 20 cc. of a thick, purulent fluid containing considerable fibrin, which was localized to the pelvis. In the right gutter there was some freshly clotted blood which weighed about 30 Gm. and measured 8 cm. in diameter. This clotted blood was lying along

the right border of the cecum. Loops of the small intestines and omentum were adherent to each other and to the anterior wall of the abdomen by a fresh fibrinous exudate. Other portions of the small intestines were adherent to the parietal peritoneum in the pelvis. The surface of the cecum was covered by a thick green fibrinous exudate, which was mixed with fresh blood. Examination of stomach and small intestines showed no unusual changes. The cecum was dark red in color and the mucosa hemorrhagic. This hemorrhage appeared to extend through the entire thickness of the wall. The cecum was unusually large and presented the appearance of a large diverticulum. The appendix had previously been removed. The sutures at its base and mesentery were well tied and showed no evidence of leakage. In the mesentery of the small bowel there were several enlarged soft pink nodes and a moderate amount of fat. There was no gross evidence of thrombosis or embolization of any of the vessels leading to the cecum. No tumor masses were found in the terminal ileum, cecum or ascending colon. On the anterior surface of the cecum there were two cystic spaces in the wall, each measuring between 2 and 3 cm. in diameter. These cysts were filled with a thick, foul-smelling green pus, but did not communicate with either the lumen of the cecum or the peritoneal cavity. *Bacillus coli* was cultured from these abscesses.

There was no evidence of any obstruction to the outflow of stool from the rectum. The liver weighed 1,800 Gm. and was covered by a fibrinous purulent exudate. The parenchyma was light brown in color and appeared grossly fatty. There was no evidence of any metastasis or abscess formation. The portal vein was not thrombosed. The gallbladder was normal. The pancreas was also normal and weighed 30 Gm. The spleen weighed 400 Gm. The organ was enlarged and covered with a thick, fibropurulent exudate. The parenchyma was soft, friable and pultaceous. The adrenal glands showed no unusual changes. The kidneys had a combined weight of 500 Gm. The capsules stripped with ease. The cortex and medulla were of normal thickness and well differentiated. There was no increase in pelvic fat. The ureters were normal. The bladder contained 120 cc. of a clear yellow urine; the prostate was not enlarged. The external genitalia were normal. Microscopic examina-

tion of these organs showed complete necrosis of the wall of the cecum with diffuse leukocytic infiltration. The mucosa was entirely destroyed. Small subserous abscesses were present. The liver contained small miliary abscesses. The parenchymal cells disclosed marked cloudy swelling. The tubules of the kidneys showed a similar process. In the mesenteric and abdominal nodes the sinusoids were dilated and congested. The follicles were intact.

#### COMMENT

The case presented was unusual in that it presented the picture at operation of a localized phlegmon of the cecum which progressed to the diffuse form, causing the death of the patient. In retrospect, one can state that the diagnosis of phlegmonous cecitis could have been made prior to operation because of the presence of a tender, palpable tumor mass in the right lower quadrant of the abdomen after a history of only twelve hours' duration.

From the available data in our patient the authors are inclined to the theory that the enterogenous route of infection was the one which occurred in the case described. There was nothing to indicate a metastatic or hematogenous infection. The organism found at autopsy, namely, *Bacillus coli*, may not necessarily have been the one originally involved, and so should be discounted.

#### CONCLUSIONS

1. A case of primary diffuse phlegmonous cecitis is presented.
2. The pathognomonic symptoms of pain and tender palpable mass in the right lower quadrant of the abdomen early in the disease are stressed.

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# AUTHOR INDEX VOLUME LXVIII

- Al Akl, F. M., 402  
 Allen, Frederick M., 170  
 Ansbro, F. Paul, 185  
 Anton, Joseph I., 303  
  
 Bacon, Harry E., 240  
 Barcham, I. S., 348  
 Belinkoff, Stanton, 318  
 Berman, Edgar F., 84  
 Blain, Alexander III., 212  
 Boutrous, Thomas A., 212  
 Breck, Louis W., 229  
 Brezin, David, 232  
 Brockbank, Mark J., 77  
 Brown, Adolph M., 338  
  
 Caswell, H. T., 383  
 Chipman, W. A., 212  
 Coburn, Donald E., 234  
 Colin, Bernard N. E., 93  
 Connell, F. Gregory, 388  
 Connolly, Paul J., 250  
 Cunha, Felix, 272  
  
 Daughtry, De Witt C., 80  
 Deardorff, Benson F., 107  
 Deibert, G. A., 391  
 Disch, Raymond, 398  
 Dixon, J. Leonard, 143  
 Doubilet, H., 348  
  
 Ehlers, Gil, 107  
 Eisenstodt, Lester W., 376  
  
 Finn, William F., 100  
 Floyd, Joe R., 77  
  
 Gass, Orville C., 240  
 Gibson, Thomas E., 49  
 Goldberg, David, 89  
  
 Harley, Garth H., 229  
 Harris, Charles M., 261  
 Heffernan, R. J., 44  
 Hoey, Waldo O., 369  
 Hyde, Theodore L., 21  
  
 Iason, Alfred H., 287  
 Ireneus, Carl, Jr., 107  
  
 Jackman, Raymond J., 323  
 Jackson, Arnold S., 358  
 James, Arthur, 103  
 Jameson, Edwin M., 369  
 Jennings, John E., 303  
 Johnson, E. K., 103  
  
 Kerschner, David, 124  
 Kessler, Leon N., 124  
 Kidd, Frank H., Jr., 87  
 Kostrubala, Joseph G., 28  
 Koven, B., 270  
 Koven, M. T., 270  
 Kretschmer, Herman L., 139  
  
 Lazarus, Joseph A., 38  
 Lee, William Y., 113  
 Levi, Leo M., 355  
 Lewison, E. F., 391  
  
 Maliniac, Jacques W., 55  
 Marks, Morris S., 38  
 Martin, George, 143  
 Martland, Harrison S., 164, 281  
 Marwil, Thomas B., 336  
 McGuigan, Walter J., 219  
 Meyer, Leo M., 398  
 Morris, Kenneth A., 120  
  
 Murbaeh, C. F., 391  
 Murray, Sam D., 344  
  
 Nation, Earl F., 67  
 Noon, Zenas B., 364  
  
 Ochsner, Alton, 143  
 Odell, Vesta, 87  
  
 Palmer, Louis A., 351  
 Polowe, David, 208  
 Pugh, H. L., 5  
  
 Rakov, Philip H., 73  
 Rexford, W. K., 250  
 Rosemond, G. P., 383  
  
 Schenk, Harry L., 364  
 Schmier, Adolph A., 116  
 Schnall, M. D., 44  
 Seltzer, Albert P., 326  
 Shafiroff, B. G. P., 348  
 Shannon, Edward W., 401  
 Skiles, James H., 266  
 Southworth, James L., 351  
 Spiegel, Milton B., 303  
 Spiegler, Arnold A., 268  
 Stewart, S. F., 127  
 Stratte, Joseph J., 91  
 Sumner, W. C., 120  
  
 Taylor, Carl E., 258  
 Teske, Jacob M., 254  
  
 Urkov, Joseph C., 195  
 Whipple, Ralph U., 297

# SUBJECT INDEX TO VOLUME LXVIII

(Bo.B.) = Bookshelf Browsing; (E.) = Editorial

## A bdomen

- injuries to, 143
- lymphangioma of, 391
- Abscess, appendiceal, and urological manifestations, 38
- Air embolism, 281
  - fatal, 164
  - in obstetrics and gynecology, 100
- Amputations of hand and prostheses, 338
- Anesthesia, balanced, and nerve block, 318
- Aneurysm, ruptured, of gastric arteries, 258
- Anus, fistulas of, 323
- Appendectomy, incision for, 344
- Appendix
  - abscess of, and urological manifestations, 38
  - inversion of stump of, 91
- Army and medical education (E.), 1
- Arnaldus Villanova (Bo.B.), 272
- Arteries, gastric, aneurysm of, 258
- Aspiration of joint fluid, 89
- Atresia, duodenal, in newborn, 120
- Avulsion, complete, of scalp, 376

## B lock, nerve, in anesthesia, 318

## Blood

- supply and mammaplasty, 55
- whole, substitute for, 348
- Bodies, metallic, removal of, 266
- Bone surgery, cellophane in, 229
- Breast, cancer of, 355
- Bridge operation for Dupuytren's contracture, 351
- Bronchus, typhoid spine perforating into, 103

## C aleancoevus, spastic, foot deformity, 116

- Calculi, salivary, 254
- Cancer of breast, 355
- Carcinoma and gastritis, 261
- Cecitis, phlegmonous, 398
- Cecum, diverticulitis of, 364
- Cellophane in bone and joint surgery, 229
- Changes, postoperative, in regional ileitis, 369
- Chemotherapy in frostbite, 113
- Childhood, hernia in, 287
- Cholecystitis, acute, 219
- Circumcision clamp, 402
- Clamp for circumcision, 402
- Clue to management of breast cancer, 355
- Colles's fracture and rupture of tendon, 234
- Colon, sigmoid, neoplasms of, 240
- Contracture, Dupuytren's, operation for, 351
- Cyst
  - pilonidal, 77
  - solitary, of kidney, 124

## D eformity of foot, 116

- Dicumarol in surgery, 80
- Disease, Mikulicz's, 358
- Dissection in hemorrhoidectomy, 73
- Diverticulitis of cecum, 364
- Duodenum, atresia of, 120
- Dupuytren's contracture, operation for, 351

## E etopia, renal, 67

- Edema, pulmonary, treatment of, 185
- Education, medical, and armed services (E.), 1
- Elbow joint injuries, 212
- Embolism
  - air, 164, 281
  - in obstetrics and gynecology, 100
- Evolution of footgear (Bo.B.), 127
- Expression, facial, fixity of, 326

## F ace, anatomical spaces in, 28

## Failure

- in operations for anal fistulas, 323
- of cure of pelvic infections with penicillin, 336

## Feeding by tube, 87

## Fistulas, anal, operation for, 323

## Fixity of facial expression, 326

## Fluid, joint, aspiration of, 89

## Foot

- deformity, 116
- plate on walking iron, 270
- shod and unshod, physiology of (Bo.B.), 127
- Fracture, Colles's, and rupture of tendon, 234
- Frostbite and chemotherapy, 113

## G astritis, hypertrophic, simulating carcinoma, 261

## Grafting of skin, by general surgeon, 195

## Gynecology, air embolism in, 100, 164

## H and

- amputations, prosthesis for, 338
- septic, care of, 232
- Hazard, a surgical, talcum powder as (E.), 279
- Hemorrhage
  - delayed, and rupture of spleen, 107
  - obstetrical, and intrasternal infusions, 44
- Hemorrhoidectomy by incision and dissection, 73
- Hernia
  - epigastric, 84
  - in infancy and childhood, 287
- History of footgear (Bo.B.), 127
- Humerus, splint for, 268

**I**leitis, regional, changes in, 369

## Incision

- and dissection in hemorrhoidectomy, 73
- transverse, for appendectomy, 344

Incurabula Medica ix (Bo.B.), 272

## Infancy

- hernia in, 287
- pyopneumothorax in, 383

Infarction, traumatic, of kidney, 250

Infections, pelvic, and penicillin, 336

Infusions, intrasternal, in obstetrical hemorrhage, 44

## Injuries

- abdominal, treatment of, 143
- to elbow joint, 212

Insufflators, powder, in gynecology, 164

Inversion of appendiceal stump, 91

Iron, walking, with foot plate, 270

Irradiation, preoperative, in breast cancer, 355

Irrigator, Nosik-Gardner, 401

## Joint

- aspiration, 89
- elbow, injuries to, 212
- surgery, cellophane in, 229

## Kidney

- cyst of, 124
- ectopic, 67
- infarction of, 250

## Limbs, surgery of, and refrigeration, 170

Locator, metal, removal of bodies with, 266

Lymphangioma of abdomen, 391

## Mammaplasty, two-stage, and blood supply, 55

### Management

- of breast cancer, 355
- surgical, of vascular trauma, 5

Manifestations, urological, and appendiceal abscess, 38

Method of repair of epigastric hernia, 84

Mikulicz's disease and penicillin, 358

Modification of Nosik-Gardner irrigator, 401

Mortality in cholecystectomy, 219

## Neoplasms, malignant, of rectum and sigmoid colon, 240

Nerve block, intercostal, in anesthesia, 318

Neuroses, surgical, and painful scar, 21

Newborn, duodenal atresia in, 120

Nose, undermining skin of, 326

Nosik-Gardner irrigator, 401

## Obstetrics

air embolism in, 100

hemorrhage in, 44

Ointment, sulfathiazole-codliver oil, for septic hand, 232

Omentum, torsion of, 303

## Operation

for anal fistulas, 323

for Dupuytren's contracture, 351

immediate and delayed, in cholecystitis, 219

Oviducts, reconstruction of, 208

Oxycephaly, true, with syndactylism, 93

## Pediatrics, urological problem in, 297

Pelvis, infections of, and penicillin, 336

### Penicillin

in Mikulicz's disease, 358

in pelvic infections, 336

Physiology of unshod and shod foot (Bo.B.), 127

### Powder

insufflators and air embolism, 164

talcum (E.), 279

Practitioner and pediatric urological problem, 297

Pregnancy and rupture of spleen, 107

Pressure respiration in pulmonary edema, 185

Problem, urological, in pediatrics, 297

Procedure for treatment of urethral strictures, 49

### Prosthesis

for hand amputation, 338

for scalp, 376

Pyopneumothorax in infancy, 383

## Reconstruction of oviducts, 208

Rectum, neoplasms of, 240

Red cell amino acid, 348

Refrigeration in surgery of limbs, 170

Removal of metallic bodies with locator, 266

Repair of epigastric hernias, 84

Respiration, pressure, in pulmonary edema, 185

Response to irradiation in breast cancer, 355

Restorations, prosthetic, for hand amputations, 338

### Rupture

delayed, of extensor pollicis longus tendon, 234

of spleen and delayed hemorrhage, 107

of urethra, 49

## Saliva, calculi of, 254

Scalp, avulsion of, 376

Scar, painful, and surgical neuroses, 21

Services, armed, and medical education (E.), 1

Skin grafting by general surgeon, 195

Skin of nose, undermining of, 326

Spaces, anatomical, in the face, 28

Specialties, surgical, and a changing world (E.), 139

Spine, typhoid, perforating into bronchus, 103

Spleen, ruptured, and delayed hemorrhage, 107

Splint, humeral, 268  
Strictures, urethral, 49  
Study, comparative, of mortality rate in cholecystectomy, 219  
Stump, appendiceal, inversion of, 91  
Substitute for whole blood transfusions, 348  
Sulfathiazole-codliver oil ointment, for septic hand, 232  
Supply of blood and manmaplasty, 55  
Surgeon, general, and skin grafting, 195  
Surgery  
    air embolism in, 281  
    and surgical specialties in a changing world (E.), 139  
    bone and joint, with cellophane, 229  
    dicumarol in, 80  
    general, and refrigeration, 170  
    of vascular trauma, 5  
Syndaetylism and oxycephaly, 93

**T**alcum powder (E.), 279

Technic for reconstruction of oviducts, 208  
Tendon, extensor pollicis longus, rupture of, 234  
Torsion, omental, 303

Transfusions, whole blood, substitute for, 348  
Trauma, vascular, 5  
Treatment  
    of abdominal injuries, 143  
    of elbow joint injuries, 212  
    of pulmonary edema, 185  
    of urethral strictures, 49  
Tube feeding, 87  
Typhoid spine, suppurative, perforating into bronchus, 103

**U**lcer, peptic, 388

Undermining skin of nose and facial expression, 326  
Urethra, strictures and rupture of, 49  
Use of red cell amino acid for whole blood, 348

**V**illanova, Arnaldus (Bo.B.), 272

**W**alking iron with foot plate, 270

World, changing, and surgery (E.), 139

